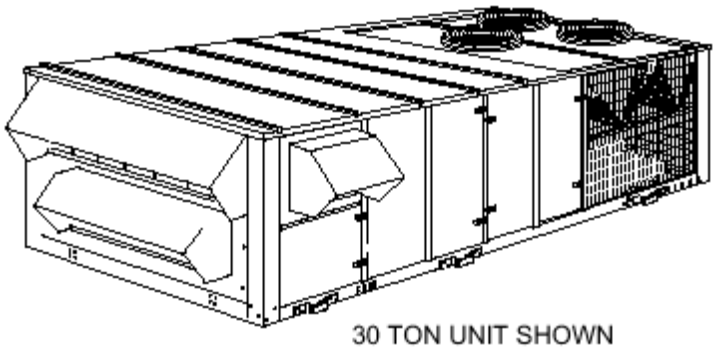
TECHNICAL APPLICATION AND PROGRAMMING GUIDE

MILLENNIUM SINGLE PACKAGE ROOFTOP UNITS
25, 30 & 40 TON EQUIPPED WITH SYNTHESYS
MOD-UNT CONTROLS



30 TON UNIT SHOWN

Millennium 25-40 Ton Single Package Commercial Rooftop Unit Equipped with Synthesys Controls

This manual includes application, programming and service procedures for the Millennium 25-40 Ton Single Package Commercial Rooftop Unit equipped with Synthesys Controls. These procedures are the same for all 25-40 Ton Millennium Rooftop units in this series except as noted.

This manual covers Synthesys controls only, for unit installation information please refer to Installation Manual Part Number 035-16682-000.

Important terms used in the text of this training are included in the Glossary of Terms.

Recommended Technical, Installation and Training Aids

Millennium 25-40 Ton Single Package Installation and Operation Manual
Form # 036-16682-000 REV A (800)

Millennium 25-40 Ton Technical Guide
Form # 036-21091-001 REV A (500)

Millennium YORKSTAR Application and Programming Manual
Form # 036-61202-000 (Rev A) 12/00

Millennium YORKSTAR Laboratory Training Manual
Form # 036-61203-001 (Rev A) 12/00

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CHAPTER 1: THE MILLENNIUM AND SYNTHESYS

1.1 Introduction and Overview

Welcome to the New Millennium! A 25 to 40 Ton single package rooftop unit with state-of-the-art digital control system that has so many features you'll find yourself the only qualified bidder! The new Millennium uses a proven digital control manufactured by Johnson Controls. The Synthesys is based on Johnson Controls "Metasys" unitary controller that has been field-tested and proven reliable for several years. This modular unitary controller is designed with the Millennium rooftop requirements in mind. The Synthesys is composed of two Mod-UNT controllers in a Master/Slave arrangement to provide 44 monitored and controlled input and output points.

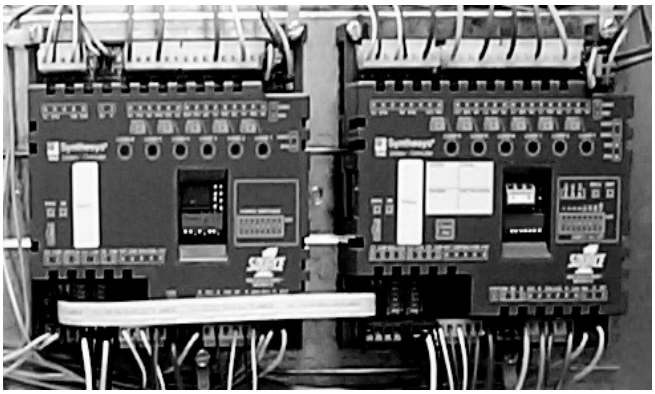


Fig 1.1: Master/Slave Mod-UNT Controllers

The Synthesys Control is a state-of-the-art computer with integrated software programming to perform all of the control and monitoring functions that were originally performed by separate discrete controls and interlocking hardware. This reduces the associated costs related to manufacture, service and maintenance.

The Synthesys digital controller includes sophisticated control of the individual components of the HVAC cooling/heating unit, and has built-in rules that protect those components. The cooling and heating modes are energized in a way that protects against frequent cycling, slugging, multiple restarts, etc.

One result is that the system may not immediately respond as you may expect. For example, internal digital timers may delay the start of a compressor even though the thermostat calls for cooling. The control may be in the middle of a timing sequence; without the observer knowing what has already happened and the status of current inputs, the system may take action not expected by the tech.

In the Synthesys control, there are:

- specific fixed rules and timings built in to the control;
- inputs monitored by the Synthesys;
- a list of user-selected setpoints and option settings recorded within the control;, and
- outputs to compressors, heat, economizers, and other options

There is a specific Synthesys configuration and model for Constant Volume (CV) units, and a different model for Variable Air Volume (VAV) units. Most of the built-in rules in the control are the same, but the two controls are not interchangeable.

DIAGNOSTICS VIA LED AND PALM

The green status LED on the master board indicates run conditions and errors (see Diagnostics Chart in the Trouble Shooting section of this manual). If more than one error is active, the highest-number error code will flash. The error details for most conditions are stored in summary in the Synthesys and can be accessed by the Palm Pilot.

Diagnosing requires patience because of internal timings. Normal observable condi-

tions are the same - contactor 4M pulled in, compressor 1 running - but the control does not identify what it has just done or is about to do.

The Synthesys control will take action according to its internal rules even though requests for change in status come from smart thermostats or zone sensors, each applying logic and timing to an installation.

Connecting and the PalmPilot

In order to communicate with the Synthesys computer, you need a computer as well. The Palm Pilot is a compact, hand-held computer with applications programs that allow you to “talk” to the Synthesys Control.

Fig 1.2: PalmPilot Configuration Tool

You can easily change setpoints or enable special control options by simply selecting the point and entering a new value.

The communication port into the Synthesys control is a telephone-style connector. There are two interface programs, one specific to the CV, one to the VAV. The Palm Pilot connection uses a special cable set and adapter attached to the built-in port on the Palm.

Additional communication devices may be attached, such as the N30 / modem / network attachment, which can allow remote access to status information from the Synthesys. Parameter changes can be done only with the Palm Pilot connection. When connected to a Building Automation System, the Synthesys will respond as a device with normal thermostat inputs. If actions are desired based on time of day, an external device must be installed; the Synthesys does not have a real-time clock function.

Password

The password system is included so you can have one person who has the ability to read data from the control and someone else who can change internal setpoint values. This protects the unit from unintended changes.

Error History and Data Snapshots

Synthesys stores up to ten of the most recent errors and a point data snapshot associated with each respective error in memory. These errors and data snapshots can be displayed when using the PalmPilot User Configuration Tool. The control will store, for each error (or combination of multiple errors), a Date and Time stamp indicating when the error occurred, and the Points Screen data. It will also store status information ("active" vs. "inactive") for all error types to provide for situations when an error data snapshot is triggered by multiple errors occurring at the same time.

The content and format of the Error History Screen and Error History Snap Shot Screen used to display this data is shown in the “Synthesys Palm Pilot Configuration Tool chapter

in this manual. Some system error will initiate a controlling response as well as being stored in the memory error buffer. See the “Troubleshooting” chapter in this manual for a detailed description of how controller errors are handled.

The control will store the last ten errors in a First In, First Out (FIFO) manner. As the control collects errors, it will overwrite the oldest error after the history buffer becomes full.

1.2 Digital Lingo

This training manual is intended to help you with the commissioning process by illustrating the use of tools like the hand-held Palm Pilot and software engineered specifically for starting up and servicing a Millennium rooftop unit. You should also become familiar with some common terminology and lingo used in the digital controls industry.

If this is your first exposure to the world of digital controls you may experience a lot of new terms, acronyms and technical lingo commonly used in the controls industry. For example, the Synthesys input and output hardware points are described as analog (relates to a continuous scale of value readings (i.e. a temperature sensor ranging from -40×F to 160×F range) or binary (meaning 2-states, either on or off, open or closed, true or false, one or zero). The term “digital” also means two states and its use is often interchanged with “binary”. These points may be either factory-installed or field-installed.

The PI algorithm

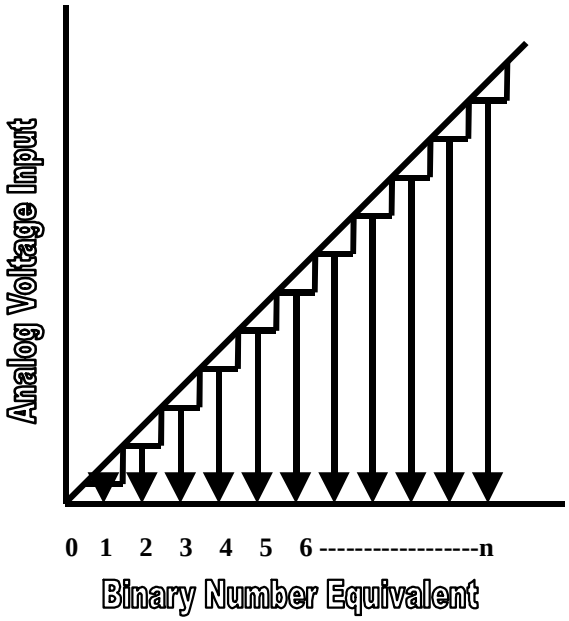
Another common “digital controls” term is the PI algorithm or Proportional-Integral control loop. The PI algorithm is a continuously updated math calculation that the controller uses to modulate an analog output point. For example a variable speed drive uses a PI loop to maintain a desired setpoint (in this case, duct static pressure control). The algorithm takes into account several parameters to calculate the output. The PI loop needs parameters such as the proportional operating bandwidth, integral time constant, deadband, desired setpoint value, sensed input value(s), start up ramp time, initial start value, maximum output control value, a status point to initiate the control action (i.e. a fan ON status), Direct or Reverse Controlling Action, and several other parameters to calculate a simple 0-100% analog output control. The PI algorithm is also called a PI loop because it “loops” the output back to the input (feedback) and determines a new output value based on the “error” or difference between the setpoint value and the sensed input value and how that difference relates proportionally to the 0 to 100% output value. Time is the “integral” constant that is factored in to increase or decrease the controlling output action depending on how long the sensed value remains away from its desired setpoint.

Fortunately, you do not have to determine all of these parameters since they are pre-programmed at the factory. You need only to set a desired setpoint and ensure that the inputs and outputs are properly wired and working. This is referred to as commissioning a system.

Analog to Digital Converter

Computers can only understand a simple binary language. Remember, “binary” means two states - ON or OFF. Analog (continuous) values of voltages, currents, and resistances are supplied by sensors and transducers to the control. These values must be converted in to a binary code so that the computer can understand them. This conversion process is performed through a combination of hardware and software. For example, the 0-10VDC analog value from a static pressure transducer is divided into thousands of steps with a

binary coded number, often called “counts”, assigned to each step.



The binary language of a computer is discussed in the Network Communications Addressing section a little later in this manual.

Software Terminology

A digital controller handles its control functions through software programming rather than with interlocking hardware and wiring. The software then becomes key to how controlled functions are handled. Software is a set of statements (referred to as the “program” that define the function of the controller’s internal microprocessor computer. Software procedurally tells the computer the sequence and order of tasks that need to be performed using a language that the computer can understand.

Software is stored in a computer’s memory. There are several types of memory in a computer. Each type has a specific function to perform.

EEPROM (Double “E” Prom) - This is a non-volatile, meaning it will not be erased on a power loss, type of memory. This memory can be written to and changed by the microprocessor. This is the type of memory that the control program is stored in the Synthesys control.

EPROM - is also non-volatile but this type of memory requires a special process to be written to. This memory is usually programmed prior to assembly of the controller. Since this memory is not changed during normal operation of the Synthesys control, only basic operation instructions are stored in this type of memory.

RAM - Random Access Memory is a volatile memory. It will be erased when a power fail occurs. This memory is used as a kind of “scratch pad” for the controller. Temporary instructions and information such as an output controlling action like driving the economizer dampers open is stored here. When a power loss occurs or if the controller is sent a manual reset using the Palm Pilot, this memory is cleared and initialized.

The Palm Pilot uses this type of memory for is own applications program storage. If the batteries are removed all of the applications including the CV and VAV programs will be lost and must be reloaded from a PC computer.

ROM - Read Only Memory is non-volatile but can not be written to. This memory is programmed only once before the controller is assembled. ROM contains instructions specifically for the internal microprocessor computer in the controller.

FIRMWARE - Firmware is the name given to the set of program instructions that are stored in EPROM or ROM memory. Where software is a more generalized term used for programming instructions and applications, it is synonymous with firmware.

FILTERING - Filters are another common term used in software programming. They are

used in Digital Controls specifically to moderate sensed input point values. For example, wind gusts will inevitably cause abnormal readings on the outside pressure when trying measuring Building Static Pressure. To stabilize the reading, a software filter is applied. This filter takes several samples of the input value, weights them, and then averages them together over several seconds. This time-averaged, weighted value is the one that is actually used for control. Other filtered inputs include temperature and humidity sensors. You should be aware of this filtering effect because it will appear the controller is not acting as fast as you may think it should. In reality, it is acting and controlling on these time-averaged and weighted values.

FAULT TOLERANCE - Fault Tolerance with respect to the Synthesys control relates to two separate issues. Hardware fault tolerance deals specifically with the electrical characteristics of the controller as to how much over voltage or power surge the controller can withstand before damage occurs.

Acronyms

A number of acronyms are used throughout this training manual. These are specific to the Synthesys control. They are also used in the Technical Guide and Installation and Operation manuals. Acronyms are used to refer to input and output hardware points and software parameters such as timing delays and setpoints.

Many of the acronyms used throughout this training manual are listed below. They are described in much more detail in the next section, Component Descriptions:

Inputs:
APS - Air Proving Switch (Fan Status)
AQ - Air Quality (CO^2 Sensor)
BS - Building Static Pressure
CS1-6 - Compressor Status
DF - Dirty Filter Status
DS - Duct Static Pressure
FS1/2 - Freeze Stat
FZR - Hot Water Coil Freeze Input
G - Thermostat input for Fan
LAR - Low Ambient Resistor
OAT - Outside Air Temperature
OCC - Building Occupied Status
P - Building Purge input
RAT - Return Air Temperature
SAT - Supply Air Temperature
SD - System Shutdown input
SO - Outside Air Enthalpy
SR - Return Air Enthalpy
SSA - Setpoint Adjust
ST - Space Temperature
W1 - First Stage Heating call from thermostat
W2 - Second Stage Heating from Tstat
Y1 - First Stage Cooling from Tstat
T2 - Second Stage Cooling from Tstat

Outputs:
C1-C4 - Cooling Outputs 1 through 4
CF1&2 - Condenser Fan Outputs
EC - Economizer Control Output
EAD - Exhaust Air Damper
EF - Exhaust Fan relay output
Fan - Supply Fan relay output
H1&H2 - Heating Stages 1 and 2 output
HW - Hot Water Valve output
PE - Power Exhaust System output
VC - VFD or IGV output
X - Relay for Alarm Status output

Miscellaneous:
AI - Analog Input
AO - Analog Output
BI - Binary Input same as
BO - Binary Output
CAV - Constant Air Volume
VAV - Variable Air Volume
VFD - Variable Frequency Drive
IGV - Inlet Guide Vane
IAQ - Indoor Air Quality
PI - Proportional-Integral Control

1.3 Communications Bus

Networked communications may also be new to you. It relates to connecting several Millennium rooftop units to a network that can be monitored and controlled remotely from network computer workstations. You will find this typically on large installations where central control, monitoring, and energy management issues become a critical factor in operating a large complex such as a manufacturing facility. The Synthesys Control has the ability to be networked into a larger system such as a Johnson Controls “Metasys” Facilities Management System (FMS). The Synthesys’ **N-2** communication network uses an “open-protocol” that allows any controls manufacturer who subscribes to the “Opto-22” opto-mux (optically isolated, multiplexed) communication protocol to communicate with the Synthesys control. A communication protocol is simply a set of rules that determine how two systems communicate with each other over some medium such as a pair of wires, phone line, radio waves, etc. The transmission medium may also be called a gateway, pathway, or bus. An open protocol is a publicly published set of rules that any equipment manufacturer can use to network into another manufacturer’s equipment.

A second communication bus on the Synthesys, called the ZONE BUS, is used to communicate to intelligent peripheral devices such as “smart” remote actuators, VAV box controllers, and other “application specific” type controllers. The Synthesys control uses the zone bus for connecting a PalmPilot Configuration Tool either directly to the controller or remotely if a Johnson Controls thermostat is used in the installation of the Millennium.

The Synthesys also has a third communications bus called the Inter-Integrated Circuit Communications Bus (or **I^2C** bus). This is a high-speed, short distance, two wire synchronous, multi-drop serial interface communication path between the Master and Slave Mod-UNT controllers.

Fig 1.3: The I^2C Bus Ribbon Cable

Whew! That’s a mouthful but rather than trying to understand what all that means, all you need to do is to ensure that the flat ribbon-type cable connecting the two control units together is securely in place and not damaged.

1.4 Component Description

This section describes the main components of MIllennium Synthesys control. These components consist primarily of master and slave MOD UNT (modular unitary) controllers, hardware inputs and outputs and the Tstat interface board.

THE MOD UNT CONTROLLER

The MOD UNT controller is a microprocessor-based unitary controller manufactured by Johnson Controls for use in HVAC applications. The MOD UNT controller provides monitoring and control for either VAV or CAV MIllennium units depending on its hardware configuration, DIP Switch settings and software programming. The two-MOD UNT arrangement provides 12 analog inputs, 12 binary inputs and up to 8 analog outputs or 17 binary outputs, depending on how the config-

uration switches and programming is set up, for a total of 17 outputs.

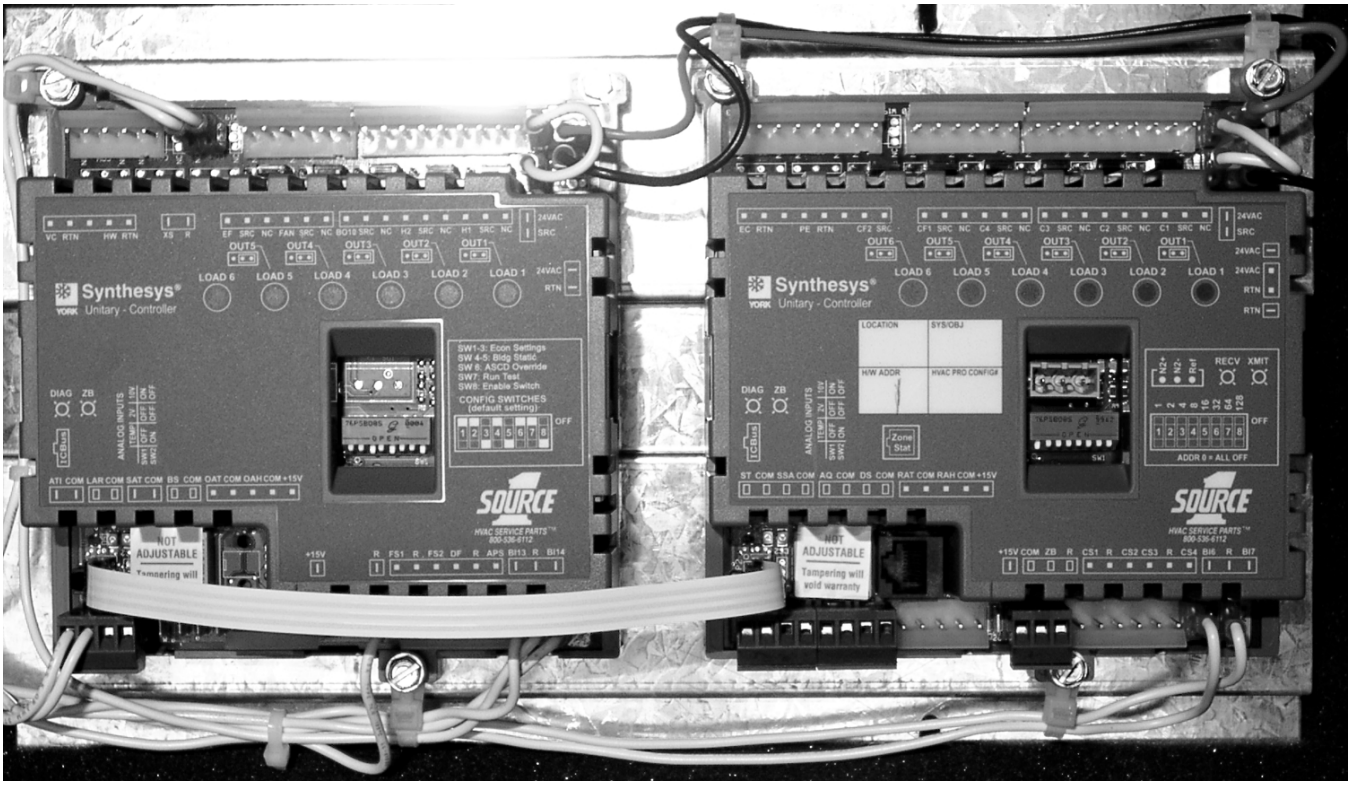


Fig 1.4: The Synthesys MOD UNT Controller

WIRING AND TERMINATION

COMMUNICATIONS

The two-MOD UNT assembly that comprises the rooftop controller uses a plug-in card for setting either a communications address or a Millennium System basic control configuration. In a networked application, a plug-in network interface card is located in the first, "master" MOD UNT controller. That card carries a DIP switch which is used only for setting the network address.

Communication Address Switch:

The master MOD UNT communication address switch is used when multiple Millennium rooftop units are networked together for centralized monitoring and control. Much like we need a unique street address in our homes so we can receive our postal mail, or emergency services, these units also need a unique address so the central Facilities Management System (FMS) can “talk” to each unit individually. The address switch allows each

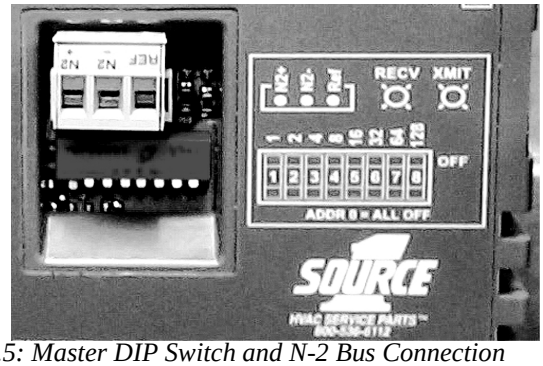


Fig 1.5: Master DIP Switch and N-2 Bus Connection

unit to be configured with its own address by selecting different combinations of switches. The address scheme uses a Base-2, or binary number system. We use a Base-10, or decimal number system in everyday life. This means simply that we have ten unique numbers (0-9) that we use to represent any number, count, or amount. The numbers count up from 0 to 9 and then start again, adding a new digit location to the left.

The Base-2 number system does exactly the same but uses only two numbers, 1 and 0. As the right-most number reaches 1, a new left digit is added and the right goes back to 0.

Binary #	Decimal
0	0
1	1
10	2
11	3
100	4
101	5
110	6
111	7

Control Configuration Switch:

The second, "slave" MOD UNT controller has a configuration DIP switch that is used in standalone applications to provide basic control settings. It is accessible to a service person who does not use the PalmPilot User Configuration tool.

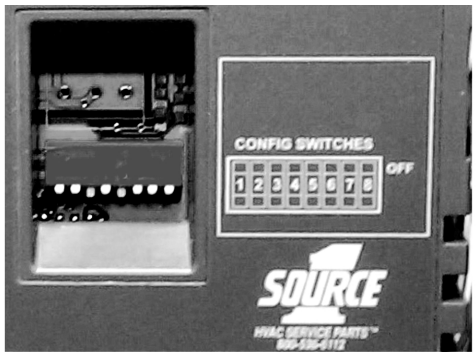


Fig 1.6: Configuration DIP Switch in the Slave Unit

As long as the DIP switch is enabled (#8 switch set to ON), the DIP switch settings take priority over the equivalent settings programmed by the PalmPilot User Configuration Tool (or over the default values of these settings set in the factory). If the DIP switch is disabled, the control uses the programmed settings. The PalmPilot software is able to read the DIP switch enable/disable status and display a note indicating this status to a PalmPilot user who is accessing and/or changing the Economizer minimum position, or Building Pressure Setpoint. Note however, that when the DIP switch is enabled and its settings take priority, the PalmPilot still displays its own programmed settings, not the DIP switch settings now in use.

Dip Switch Positions								Operation
1	2	3	4	5	6	7	8	
Economizer / Minimum Ventilation Position								Economizer / Minimum Ventilation Position
Off	Off	Off	-	-	-	-	-	No Economizer Attached
On	Off	Off	-	-	-	-	-	Economizer W/ 0% Minimum Outdoor Air
Off	On	Off	-	-	-	-	-	Economizer W/ 10% Minimum Outdoor Air
On	On	Off	-	-	-	-	-	Economizer W/ 15% Minimum Outdoor Air
Off	Off	On	-	-	-	-	-	Economizer W/ 20% Minimum Outdoor Air
On	Off	On	-	-	-	-	-	Economizer W/ 25% Minimum Outdoor Air
Off	On	On	-	-	-	-	-	Economizer W/ 30% Minimum Outdoor Air
On	On	On	-	-	-	-	-	Economizer W/ 35% Minimum Outdoor Air

Building Pressure Setpoint								Building Pressure Setpoint
-	-	-	Off	Off	-	-	-	.025 in. w.g.
-	-	-	On	Off	-	-	-	.050 in. w.g.
-	-	-	Off	On	-	-	-	.100 in. w.g.
-	-	-	On	On	-	-	-	.150 in. w.g.
ASCD Override								ASCD Override
-	-	-	-	-	Off	-	-	Normal Operation
-	-	-	-	-	On	-	-	Override all ASCDs for one cycle with 30 seconds
Run Test (Commissioning Operation)								Run Test (Commissioning Operation)
-	-	-	-	-	-	Off	-	Normal Operation
-	-	-	-	-	-	On	-	Run Test for one Cycle
								DIP Switch Enable / Disable
-	-	-	-	-	-	-	Off	disabled
-	-	-	-	-	-	-	On	enabled

The one-time commands to Override ASCD timers and/or to start Run Test can be issued by either the PalmPilot User Tool, or by the DIP switch, if enabled.

The DIP switch is shipped from the factory with the #8 switch in "Enabled" position, and with #6 and #7 (command) switches set to OFF, and with switches #1 through #5 set for a default 20% minimum Economizer position and 0.100" w.g. building pressure setpoint.

INPUTS

There are two types of hardwired input points on the Synthesys control: Binary and Analog. A single MOD UNT can have up to six analog inputs (AI) wired to its terminals. These may be sensors, feedback, or adjustable setpoints. Typical AI points include Space Temperature (ST), Supply and Return Air Temperatures (SAT, RAT), and Building Static Pressure (BS). There are six binary inputs (BI) on the MOD UNT. These use a dry contact input to determine the status of a monitored point. Typical BI points are Fan Status (APS), Filter Status (DF), and Compressor Status (CS1-4).

Analog Inputs (AI):

Analog inputs require parameters that define the input's characteristics. Attributes of an AI includes the linear range, alarm limits, alarm differential, change of state (COS) enable, and fIlter weight. The input values may be overridden by a command from the N2 bus or by using the Palm Pilot Configuration tool. This is useful to override current conditions to test certain control functions or modes.

ST - Space Temperature sensor is a field-installed sensor (PN: 2ET04701424A - w/ Override Button) or (PN: 2ET04701524A - w/ Override and Setpoint Adjust). The sequence of control for space temperature is different depending on whether the system is a VAV or CAV. See chapter on Sequence of Operation for a detailed description of the ST control modes. This sensor also has a zone bus connection that can be used (if wired) to remotely connect the Palm Pilot Configuration Tool to the Synthesys unit (see Fig. 1.3).

SSA - Space Temperature Adjust is field-installed. It is a slide adjustment located on a space sensor (PN: 2ET04701424 A) with a slide bar potentiometer. It is used to offset the

space temperature setpoint. This slide-bar is a 10K ohm potentiometer. The programmable range for the Setpoint adjust is +/- 5×F. For example, if the Space Temperature setpoint is set to 74×F, the SSA is programmed to +/- 3×F and the SSA is adjusted fully to the + position, the new controlling space setpoint will be 78×F.

OAT - The outside air temperature sensor (PN: 031-01916-000A) is a factory-installed 1K nickel resistive sensor. Its linear ranging is from -50×F to 250×F.

OAH - Outside Air Humidity (PN: 025-32601-000-A) is a factory-installed sensor manufactured by JOHNSON CONTROLS (HE-6320-50). OAH sensor provides a 0-5VDC signal to the controller over a range of 0 to 100% relative humidity. This input is used for the economizer calculation to determine whether free-cooling is available and to switch between minimum outside air and using outside air as the first stage of cooling.

SAT - Supply Air Temperature sensor (PN: 031-01915-000A) is also a factory-installed -50×F to 250×F, 1K at 70×F nickel sensor.

RAT - Return AIr Temperature sensor (PN: (PN: 031-01917-000A) is a factory-installed -50×F to 250×F, 1K at 70×F nickel sensor.

RAH - Return Air Humidity (PN: 025-32601-000-A) is a factory-installed sensor manufactured by JOHNSON CONTROLS (HE-6320-50). The OAH sensor provides a 0-5VDC signal to the controller over a range of 0 to 100% relative humidity. The control will calculate the return air enthalpy using the relative humidity and return temperature inputs.

In dual-enthalpy mode, the outside air enthalpy is compared with the return enthalpy to determine if the outside air is more economical to use for cooling than the return air.

LAR - Low Ambient Detector (PN:031-01914-000A) is really a 1K ohm 1/4Watt 1% resistor that is installed on the LAR input to the controller to tell the control that a Low Ambient Kit is installed on the unit. The control will then allow operation of mechanical cooling down to 0×F. Low Ambient control can also be enabled through the software from the factory or with the hand-held Palm Pilot configuration tool. If a LAR resistor is not used, a Hot Water Freeze protection switch may be installed on this input. See the Sequence of Operation for a description of the H_2O freeze protection control mode.

IAQ - Indoor Air Quality. The IAQ provides a 0 to 10 volt d.c. signal to the control from a Carbon Dioxide (CO_2) sensor. Indoor air quality is monitored for adequate ventilation. In Demand Ventilation Mode, as the CO_2 levels in the building rise above the programmed setpoint, more fresh air must be brought in. The economizer is therefore adjusted to a more open position as necessary. The linear ranging for IAQ sensor input is from 0 to 10,000ppm. The Demand Ventilation setpoint is adjustable from 750 to 1500 ppm and is set at the factory at 1000 ppm. This device is field installed.

DS - Duct Static pressure is monitored by a factory-installed 0-5VDC transducer (PN: 031-01209-000A). The high-pressure port sensing tube installed in the field. The sense tube should be located approximately two-thirds of the way down the duct plenum. To prevent an unstable signal due to air turbulence, there should be no obstructions, turns or VAV terminal boxes up or down-stream of the sense tube location for at least 6 to 10 times the diameter of the duct. he sensor is located in the control housing just below the MOD UNT controllers.

BS - The building static transducer (PN: 031-01262-000A) is a factory-installed Johnson Controls DPT-2640-522 transducer that provides a 0 to 5VDC signal to the controller over a range from -0.250”WC to +0.25”WC. The transducer is located in the control housing just below the MOD UNT controllers. The sense tube is field-installed with the outside pressure being sensed external to the unit. To avoid an erratic pressure reading, the building pressure sense tube should be mounted in the space in an area away from the return air grill, discharge diffusers, doors and windows.

Y1, Y2, W1, W2 - If a thermostat is installed on the system, these inputs will take priority over software-programmed setpoints and limits. A thermostat interface board is used to convert the thermostat signals to analog (voltage) and binary (on/off) input status signals. The four cooling and heating signals (W1, W2, Y1, and Y2) from the thermostat are converted into a single 0-5vdc analog signal that is directly proportional to the heating or cooling demand of the thermostat. This is a cost-effective way of multiplexing input points. This input is then decoded by the software into the thermostat’s actual demand status.

***BINARY INPUTS (BI)*:** Binary points are two-state inputs that represent an off/on, open/closed, true/false, occupied/unoccupied or any other dual state condition. The binary input is typically used to report dirty filter status, building occupancy, purge and shutdown mode requests, thermostat heating, cooling and fan calls and the Supply Fan status. Compressor and refrigeration system freeze status inputs are also binary inputs to the control.

APS - Supply Fan status is monitored by an Air Proving Status switch (PN: 024-27557-000A) installed and calibrated at the factory. The APS is a differential pressure switch that monitors the difference in pressure between the suction and discharge of the fan.

CS1 through CS4 - These four binary inputs report the status of the CONTROL voltage and safety circuit to Compressors 1 through 4 relay modules. The refrigerant low pressure (LP) and high pressure (HP) safety switches, and the compressor motor overloads are wired in series with the output from the controller to terminal M1 of the compressor module. If any safety opens, the control voltage from the MOD UNT binary output is interrupted and the status is lost at the CS input.

G, OCC, SD, P - These signals represent Fan (G), Building Occupancy (OCC), System Shutdown (SD), and Building Purge (P) calls from the thermostat. If a thermostat is installed on the system, these inputs are connected to the thermostat interface board just as are the cooling/heating calls described above. These inputs are connected through the Tstat Interface board directly to the respective binary inputs of the Controller. These signals are, however, each loaded with a 750 ohm resistor to maintain voltage levels and to prevent “floating” of signals. Thermostat wiring is typically not shielded and may have induced voltages that could cause errant signal readings by the controller.

DF - Dirty FIlter switch input to provide a filter status to the control. The control will wait for one minute after the DF closes before declaring a Dirty Filter Alarm.

OUTPUTS

There are two types of hardwired output points on the Synthesys control: Binary and Analog. There four analog output points to drive variable devices such as valves or damper actuators and 5 binary output points to operate two-state devices such as a fan start/stop relays or compressor motors.

Analog Outputs (AO)
Analog outputs can provide a 0-10vdc or 4-20ma signal to operate controlled devices. The Synthesys is currently configured to use only 0-10vdc outputs to the Variable Frequency Drive, Inlet Guide Vane, Economizer Damper, and Heating water valves. SInce these outputs are analog, they are continuous between 0 and 10 volts and are proportional to the 0 to 100% drive position of the device.

EC - Economizer Actuator

The modulating Economizer uses a Belimo AF24-SR.9 spring-return actuator (PN:025-30869-000A). This actuator uses a 0-10VDC signal to drive the dampers open. The actuator drives 95 degree rotation. Note the chart below for a correlation between the input drive signal at terminal 3 (Y1) of the Belimo actuator and the corresponding output drive position of the damper:

Input Signal to Y1	Actuator Position
10VDC	90 degrees
9	78
8	67
7	56
6	45
5	33
4	22
3	11
2	0
0	-5
8VDC over a 90 degree Span = 11.25 degrees/VDC	

VC - Inlet Guide Vane/VFD. The Inlet Guide Vane uses a Belimo AF24-SR.9 spring-return actuator (PN:025-30869-000A). This actuator uses the 0-10VDC signal from VC+/RET terminals to drive the dampers open. The actuator drives 95 degree rotation. Note the chart above for a correlation between the input drive signal at terminal 3 (Y1) and the corresponding output drive position of the guide vane.

If the unit has a factory-installed Variable Frequency Drive, the 0 to 10VDC signal is wired from VC+/RET output directly to the VFD's input terminals.

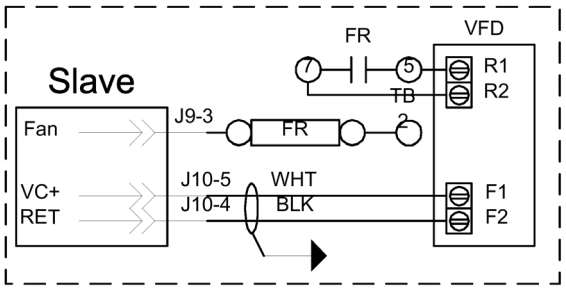


Fig 1.7: VC+/RET output to VFD Wiring

PE - Power Exhaust System

Power Exhaust Damper Actuator is a BELIMO AF24-3-S 24VAC. It uses a full open/ Full Closed scheme and operates a 95 degree rotation.

HW - Heating Water Valve

Binary Outputs (BO)
Binary outputs provide a normally open or closed relay contact to drive devices such as a Fan or compressor contactor. A 24VAC power is common to the "SRC" terminal of the MOD UNT and the fan or compressor relay is connected to the normally open terminal of the MOD UNT.

FAN - Fan Start/Stop Relay

H1 & H2 - Heat Stages 1 and 2

C1 through C4 - Cooling Stages 1 through 4

CF1 & CF2 - Condenser Fan Banks 1 and 2

PE - Power Exhaust

X - Controller Alarm is field-wired from the thermostat interface board to a thermostat that has an LED light to signify a controller alarm has occurred.

Chapter 2: Synthesys Palm Pilot Configuration Tool

2.1 Users Guide

The Palm OS Configuration Tool is intended to be the primary method for commissioning and configuration of the SYNTHESYS controller used on the York Millennium Rooftop Unit. The SYNTHESYS controller is based on the Johnson Controls Mod-UNT platform. The Configuration Tool provides service personnel with a portable device that can be used to view and adjust setpoints and operational parameters for the controller, and to monitor input and output values.

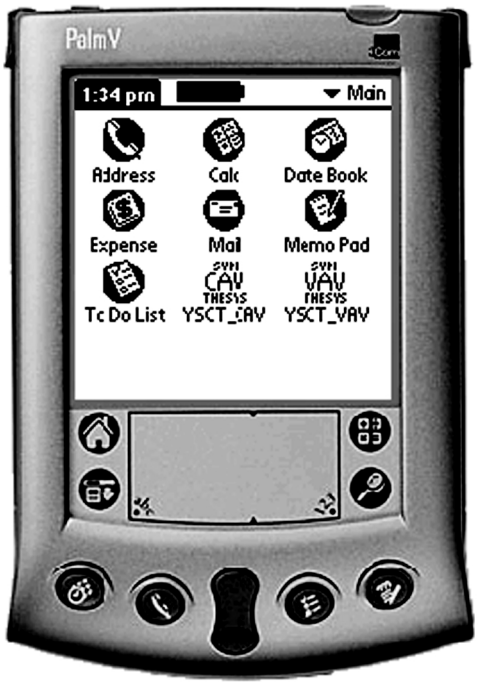


Fig 2.1: Palm Pilot Configuration Tool

There are two versions of the Configuration Tool- one to be used with CAV applications (YSCT_CAV) and one to be used with VAV applications (YSCT_VAV). The only difference between the two is that some parameters specific to one application will not be displayed in the other.

Device Description

The Palm device is a personal digital assistant that uses the 3COM Palm OS. It is available in several models (Palm Pilot Pro, Palm III/IIIx, Palm V, Palm VII). The Configuration Tool is requires Palm OS version 3.0 or later (found on the Palm III, Palm V, and Palm VII), and will not work with older Palm Pilot models (such as the Palm Pilot Pro).

User inputs are made via a stylus on a touch sensitive screen and a row of buttons at the lower end of the device. A serial port is used for data transfer between the Palm device and PCs or other devices.

You can input text and numeric data in two ways: writing out the “Graffiti” alphanumeric characters used by the Palm OS handwriting recognition software, or tapping the characters into the on-screen keyboards.

The data entry area on the Palm device is located directly below the display screen and is divided into two sections: the left side is used to input letters and punctuation marks, the right side is used to input numbers and math symbols. Tracing out a Graffiti character on the data entry area will cause that character to be entered onto the display screen.

The on-screen keyboards are accessed by tapping the point labeled “abc” at the lower left corner of the data entry area or the point labeled “123” at the lower right corner of the data entry area. Characters are then entered by tapping keys with the stylus.

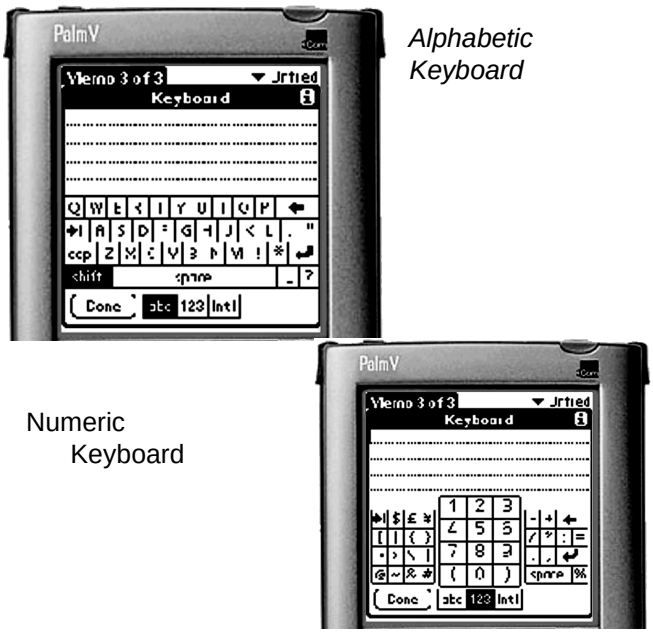


Fig 2.2: Alpha-Numeric Screens

Connecting to the Mod UNT

The configuration tool is connected to the Mod UNT’s Zone Bus jack by means of a Cable-Pro Zone Bus/ RS232 (AS-CBLPRO-2) converter. A Palm Hot Sync cable and a null-modem adapter (DB9 male/DB9 male) are used to connect the Palm to the Cable-Pro’s RS232 connector (If a Palm III Modem Cable is used, the null-modem adapter is not needed, but a DB25 female/DB9 male adapter is required). The Zone Bus cable provided with the Cable Pro connects to the controller (*see figure below*). In a controller configuration with a ‘primary’ and ‘secondary’ Mod UNT (as is used with the SYNTHESYS system), the tool should be connected to the ‘primary’ board.

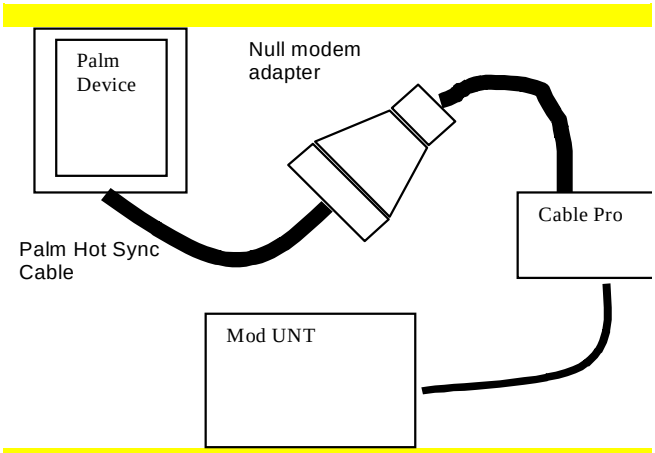


Fig 2.3: Connection of Palm device to Cable Pro and SYNTHESYS Mod UNT board

Starting the tool, Opening Screen

Tap on the ‘YSCT’ icon to start the tool—the CAV icon

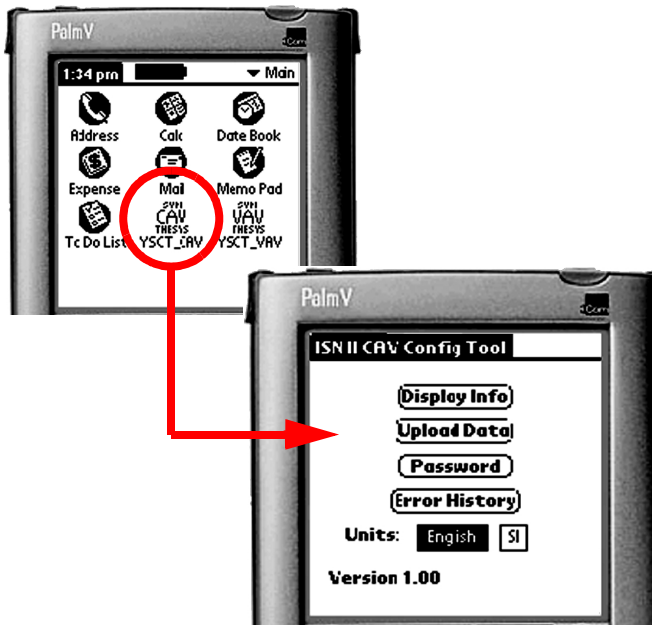


Fig 2.4: Application and Opening Screens

for configuring a CAV system, the VAV icon for a VAV system. The opening screen will then be displayed. The ‘Display Info’ button leads to the data display screens. The ‘Upload Data’ button opens communication with the controller and uploads parameter and point values for display. The ‘Password’ button will go to the password screens. ‘Error History’ will load data

recording system faults from the controller and display it.

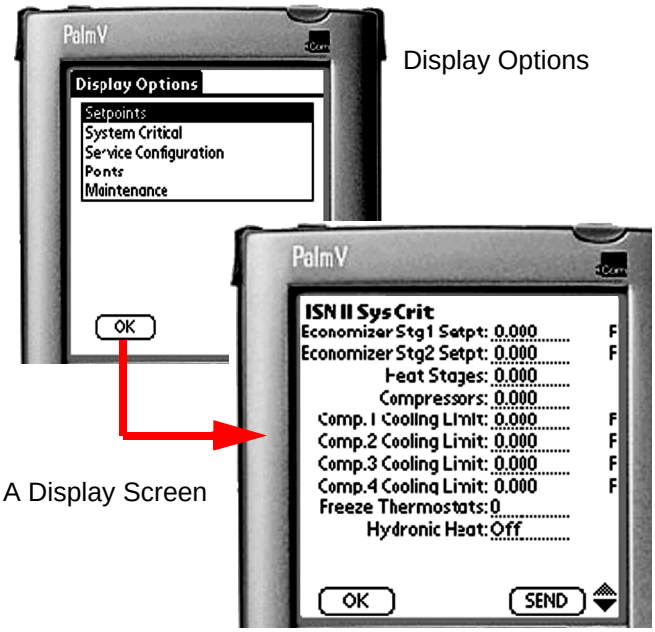
The Units push buttons allow you to select English or SI (metric) units. If SI is selected, all values are converted to and displayed in SI units. Changed values are converted back to English units prior to transmission to the controller (the controller handles all values internally as English units).

Uploading Data

When the 'Upload Data' button is selected, the Palm will establish communication with the controller and upload data. A Data Hot Sync icon is displayed on the screen until the upload is complete. A full data upload takes 5-10 seconds. If for some reason the Tool is unable to establish a connection to the controller, an error screen is displayed after a couple seconds indicating a 'time-out error'. Double check that all cables are properly connected and that the controller has power if this occurs.

Display Screens

Tapping the 'Display Info' button will take you to the Display Options Screen. A list of the available display screens is shown. Tapping on the display screen items will take you to the selected screen. If no data has been loaded from the controller, a 'No Data Uploaded' message is displayed and all parameter values will show as either 0 or 'Off'.



Display Options

A Display Screen

Fig 2.5: Display Options and DIsplay Screens

Each display screen is formatted as a columnar table: Item Name, Value, Units, and (for Points screen) Override status. Up to ten items can be visible on the screen at once. Tapping the scroll arrows at the lower right corner of the screen will scroll the display one item at a time. The scroll buttons on the Palm will scroll a full screen at a time (i.e., "page up/down").

Entering Values

Items can be changed only if the password access level is high enough for the current screen (see Passwords below). If the access level is not high enough and you try to change a value, an alert screen is displayed indicating that the access level is not high enough to allow changes, and any changes to the displayed values are rejected.

To select an item to change, tap the Value cell to set the cursor, or drag the stylus across the Value cell to highlight and select it. The new value can then be entered using either Graffiti or the on-screen keyboards. For Boolean values, entering "on" or "t" will set the value to True, entering "off" or "f" will set the value to False.

The Configuration Tool has a range checking feature that verifies that numeric inputs are within the valid range for the parameter being altered. Inputs outside the valid range are not accepted and an alert screen is displayed indicating that the entered value is out of range.

Parameter Groups

Some parameters need to be correctly set in relation to other parameters—such parameters form a *parameter group*. When you tap on a parameter that is part of a

Fig 2.6: Parameter Group Screen

group to change it, the display will switch to showing

just the members of the group. After the desired changes are made, tapping the OK button will set the new values and return to the main display screen. If the new values don't have the proper relationship to each other, an alert screen is displayed showing what the correct relationship is and the tool will remain in the group screen so that the entries can be corrected.

Fig 2.7: Group Relationship Alert Screen

Tapping Cancel will return to the main display screen without setting changes. The parameter groups which the Configuration Tool recognizes are as follows:

- Occupied and Unoccupied heating and cooling setpoints are set in an ascending sequence as illustrated below:

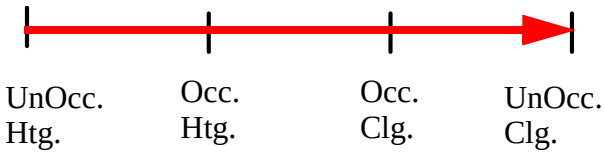


Fig 2.8: Sequence of Setting the Setpoints

- Compressor Cooling Limits and Economizer Stage Setpoints: Compressor 1-4 Cooling Limits must be in ascending order of values, and must all be below the lower of the Economizer 1st Stage Setpoint and Economizer 2nd Stage Setpoint.
- Economizer stage setpoints: must be in descending order of values.
- Hydronic Heat Stage setpoints and Economizer Heat Loading Setpoint: Hydro. Stages must be in ascending order of value, Econ. Heat Loading (CAV only) must be higher than both.
- Supply Air Alarm setpoints for heating/cooling: cooling setpoint must be lower than heating setpoint.
- VAV High and Low Temperature setpoints for cooling: high setpoint must be greater than low setpoint.
- Comfort Ventilation High and Low Supply Air setpoints: high setpoint must be greater than low setpoint by 10 deg. F/5.5 deg. C.
- Pre-Occupancy Purge High and Low OAT Limits: high limit must be greater than low limit.
- Heating/Cooling Lockout on OAT: heating lockout temp. must be greater than cooling lockout temp.
- Space Temperature Alarm Differential and Space Temperature Alarm Time must both be either enabled or disabled—one can not be enabled while the other is disabled.
- Condenser Low Ambient Operation and Condenser Fan Operation: Condenser Low Ambient Operation can only be ON when Condenser Fan Operation option is set to 2.
- Economizer, Economizer Loading, Power Exhaust, and Modulating Exhaust: Economizer must be ON for Power Exhaust and/or Economizer Loading to be ON, both Economizer and Power Exhaust must be ON for Modulating Exhaust to be ON.

- Economizer Damper position for Exhaust Fan to turn ON/OFF: ON point must be at least 10% higher than OFF point.
- Exhaust Damper position for Exhaust Fan to turn ON/OFF: ON point must be at least 10% higher than OFF point.

Sending Changes

After changes have been made, tapping the 'SEND' button on the display screen will open communications with the controller. The values are transmitted to the controller, and then an upload of data from the controller to the Palm is done to ensure that the tool is in sync with the controller. Upon exiting the screen, you are prompted to send changes if there are any values that have been edited but not transmitted to the controller. Un-sent changes are retained in the Palm until you select a different data screen (so that if you mistakenly exit a screen you can return to it without having to re-enter changes).

Refreshing Screens

Values on the Points and Maintenance screens are updated from the controller to the main data array in the background. When the Points or Maintenance screens are re-entered after having been to a different screen, fresh values are displayed. Tapping the 'Refresh' button on the Points and Maintenance screens will initiate a full refresh of all values in the Tool from the UNT.

Overrides

Some of the Analog and Binary I/O items displayed on the Points screen are overridable. Overridden status is indicated by a check in the override status box in the far right column of the screen. When a value is changed, the check mark will appear to indicate the overridden status, and the controller values are overridden when the Send button is tapped. Setting a check in the box without editing the value will override the point to its currently displayed value.

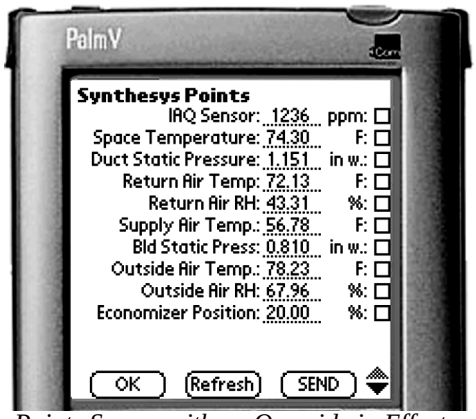


Fig 2.9: Points Screen with an Override in Effect

Overrides are released by tapping on the check boxes to clear check marks and then tapping Send. Overrides made to the controller are released upon exiting the commissioning tool, whether or not a controller reset is done.

If for any reason the commissioning tool is exited abnormally (cable disconnected, Palm Pilot reset) the controller will automatically release any overrides made 10 minutes after Zone Bus communication was lost with the tool. (To release overrides prior to the 10 minute time-out, the controller must be reset either by reconnecting the tool and issuing a reset command, or by cycling power).

Items such as Compressor states and Heat Stage states are not overridable. Changes made to those items are not accepted and an alert indicating that they can not be overridden is displayed.

Commands

A set of command buttons are reached by tapping the 'commands' button that appears at the bottom of the Service Configuration screen.

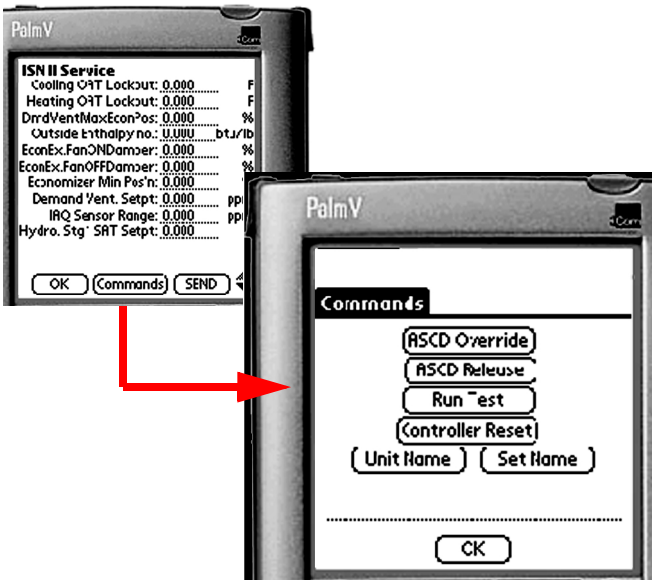


Fig 2.10: Service Configuration and Command Screens

The command buttons are:

- ASCD Override- sets the controller in ASCD override mode
- ASCD Release- releases ASCD override mode
- Run Test- sends a Run Test command to the controller
- Controller Reset- sends a reset command to the controller
- Unit Name displays and allows editing of the name assigned to the controller
- Set Name sends the name shown in the name field to the controller

All of the commands except Controller Reset and displaying the Unit Name require Password level 2 or higher.

Passwords

Entering Passwords

The password screens are accessed by tapping the Password button on the Opening screen. The Enter Password screen is where you can enter a password to move to a higher level of access.

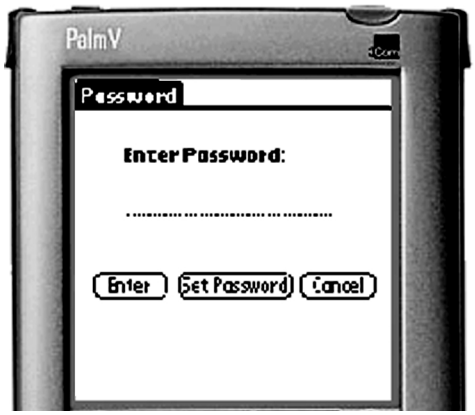


Fig 2.11: Enter Password Screen

When the tool is started, it is at access level 0, which does not allow changing of any displayed values. To go to a higher level, write the appropriate password in the text field and tap the Enter button. An alert indicating that N2 communications is suspended is displayed, followed by either a confirmation that the password was accepted or an alert that it was incorrect.

There are three access level passwords. Level 1 allows changing of only those values on the Setpoints screen. Level 2 allows changing of all values except those on the System Critical screen. Level 3 allows changing of System Critical parameters.

The default passwords for the three levels are set when the Configuration Tool is first installed. The default passwords are given in the attached appendix.

Changing Passwords

Passwords can be changed by tapping the Set Password button in the Enter Password screen. In the Set Password screen, you must select the access level

whose password is changed using the 1-2-3 push buttons on the screen.

Fig 2.12: The SET PASSWORD Screen

The current password for the selected access level must be entered in the ‘Enter Old Password’ line, and the desired new password must be entered twice on the ‘Enter New Password’ and ‘Confirm New Password’ lines. Tapping the Enter button will then change the password. Passwords may be up to 20 characters long- you are prevented from entering more than 20 characters on the line. If the old password is incorrect or if the two entries of the new password do not match, the password is not changed and an alert is displayed.

Disabling of N2 Communications

In order to prevent conflicting changes to be made simultaneously by a user with the Palm Pilot tool and another user connecting over the N2 bus, the Palm Pilot tool disables N2 communication whenever an access level higher than 0 is set.

Fig 2.13: Disabling of N2 Communications

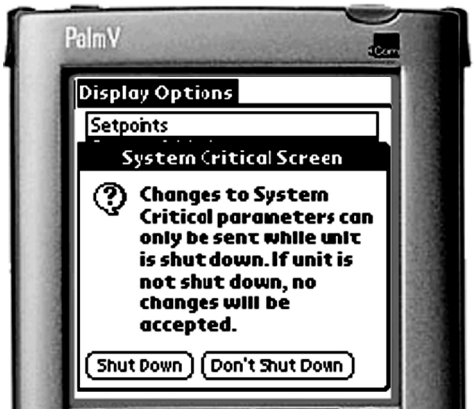

PalmV
Display Options
Setpoints
System Critical Screen
Changes to System Critical parameters can only be sent while unit is shut down. If unit is not shut down, no changes will be accepted.
Shut Down
Don't Shut Down

Fig 2.14: System Critical Screen

If there is anyone monitoring the controller over the N2 bus, you may want to inform them that you will be temporarily disabling N2 communications.

When the Palm Tool is exited, N2 communications can be restored by resetting the controller, or will be automatically restored after 10 minutes.

Shut Down Command

If you are at access level 3, entering the System Critical screen will display a dialog box giving you the option to issue a Shut Down command to the controller. If the controller is shut down, you are able to make changes to the System Critical parameters. If the unit is not shut down, changes to System Critical parameters are not allowed.

Upon exiting the System Critical screen, you are given the option of restarting the unit if it was shut down. If the unit is not restarted after exiting the System Critical screen, it is restarted upon exiting the application. If the application is exited abnormally, the controller will have to be reset either by reconnecting the Palm Pilot tool and issuing a reset command, or by cycling power to the controller.

Error Screens

The SYNTHESYS controller has a mechanism for recording fault conditions that occur. Up to ten fault records are stored on a First-In-First-Out basis—once the faults buffer is full, new errors occurring will replace the oldest record in the buffer. The error code for each stored fault indicates what error conditions were active at the time. For each record in the buffer a ‘snapshot’ showing the value of the Points screen parameters is also stored.

There are 12 error conditions recognized by the Configuration Tool:

- Compressor locked out on safety chain trip
- Supply fan failure
- Heating SAT failure
- Cooling SAT failure
- [2] SAT,RAT,OAT,IAQ, Space Sensor, or a RH sensor failure
- Duct static or Bldg. Pressure sensor failure
- Dirty Filter alarm
- High duct static alarm

- Space temperature alarm
- Hot Water Coil Freeze alarm
- External alarm input
- Bad Air Proving Switch
-

More than one condition can be in effect simultaneously.

Error History Screen

The Error History Screen displays the ten fault records stored in the controller, in order from most recent (top) to oldest. The first column displays the name of the error condition. Note that it is possible that more than one condition may be active; the name of the first occurring condition in the order of the list given above is displayed.

PalmV
Error History- top most recent
Compressor LockOut: P: 2: Active
Compressor LockOut: N: 2: Active
Bad Air Proving Switch: N: 2: Inact.
High Duct >tatic: N: 2: Inact.
Cool SAT: N: 2: Inact.
Sensor Failure: N: 2: Inact.
Hot Water Coil Freeze: N: 2: Inact.
Econ. Min.Pos'n: N: 2: Inact.
Heat SAT: P: 2: Inact.
Supply Fan: P: 2: Inact.
OK
Reset History

Fig 2.15: Error History Screen

The second column indicates whether the condition is a new condition (N), or a pre-existing condition (P) which is now displayed because a previous condition with a higher display priority is no longer in effect.

The third column indicates the number of error conditions that were in effect at the time the fault was recorded.

The fourth column indicates whether any of the conditions in the fault record are still currently active or if they have since gone inactive. It takes approximately 30 seconds after a fault condition becomes active to update the Palm to the new fault status (i.e., a newly active fault may be displayed as 'inactive' until 30 seconds has elapsed).

Tapping on one of the fault records will recover the snapshot data for that fault from the controller and display them on the Error Snapshot screen.

The Error History Reset button at the bottom of the screen allows you to clear the error data stored in the controller. The password level must be set to 3 to clear the error data.

Error Snapshot Screen

The Error Snapshot screen displays the detailed snapshot associated with each fault record.

Fig 2.16: Error Snapshot Screen

At the top of the Snapshot table are the sequence number (the number of faults that had occurred since the controller was installed), and the numerical value of the error code. Immediately below are the time and date of the fault record. If the controller is not connected via its N2 bus to a network that can provide it with a real time and date, the date is displayed as 0/0/00 and the time will represent only an hours/minutes counter that starts from 0:00 each time the controller is reset and rolls over every 24 hours.

The next 13 items in the table list all the error conditions and indicate whether or not they were active at the time of the fault record. Below the fault conditions list is a copy of the data from the Points screen at the time of the fault. Items that were unreliable at the time of the snapshot are shown as asterisks.

Reset on Exit

Exit the tool by tapping the ‘applications’ icon on the Palm Pilot below the display. On exit, you are given the option to issue a re-sync command on exit. The re-sync command will cause any changes made to parameters to be backed–up to the EEPROM memory on the secondary Mod-UNT the next time the controller is reset. Since the secondary’s EEPROM backup is used to restore the primary controller’s EEPROM should it become corrupted, it is highly recommended that you issue a re-sync on exit if any changes were made.

Fig 2.17: Exit Re-Sync Dialog

You will then be prompted to issue a reset command. Issuing a reset command will clear any overrides and/ or a shut-down state, and back-up any parameter changes if the re-sync command was sent. If you choose to exit without resetting, the tool will clear any overrides that are still shown as active.

Fig 2.18: Exit Reset Dialog

If the unit is in shut-down state when the tool is exited, a restart command will automatically be sent as part of the exit sequence.

APPENDIX- Default Passwords

The default passwords for the current release are:

- Access Level1: level1
- Access Level2: level2
- Access Level3: level3
-

Chapter 3: Synthesis Programming Options

The paragraphs below provide a definition of, and specify the function related to each of the parameters that are field-adjustable using the PalmPilot Configuration tool. The Millennium Unit is shipped from the factory with the necessary options pre-programmed as indicated by the model nomenclature. It is always a good practice, though, to verify that the correct parameters are properly configured for the unit you are commissioning.

You can find a complete list of field-adjustable parameters in the “Option Chart and Default Values” provided in the Appendix.

Each of the programmable parameters described in this section are organized by the screen on which they appear on the PalmPilot Configuration Tool. For a description of each of the PalmPilot commissioning screens, see the “PalmPilot Configuration Tool” chapter in this training manual.

3.1 Initial StartUp Options

Commissioning a new Millennium installation requires some field adjustments to the Synthesys control program. Most of these adjustments simply involve setting up the various setpoints that are specific to your customer’s needs (i.e. building pressure) or enabling some extended options that are integrated into the Synthesys control. Also, if field-installed accessories, i.e. a modulating power exhaust option, are added, the control program will need to be modified for the new Millennium configuration.

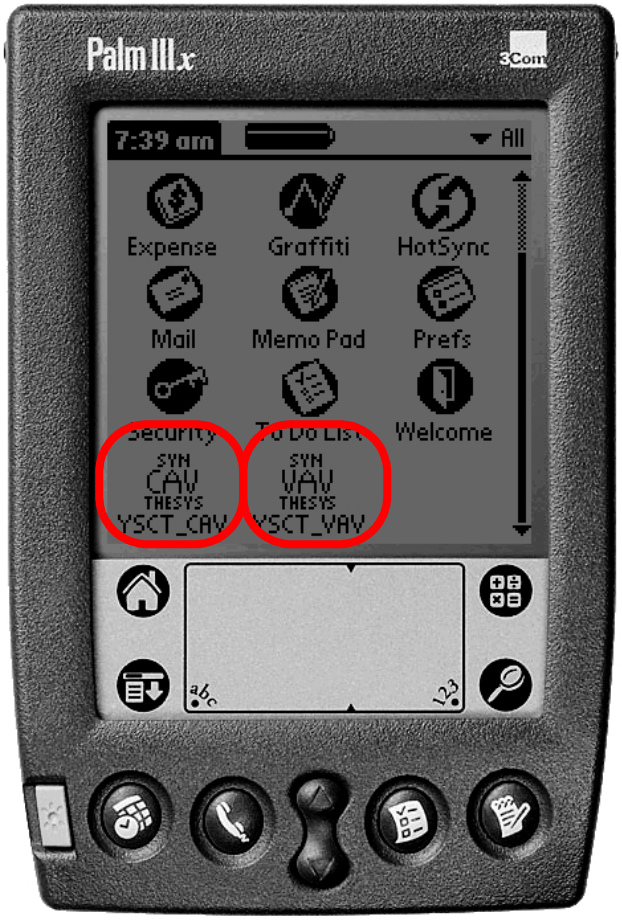


Fig 3.1: PalmPilot Applications Screen

From the PalmPilot Applications Screen, select the type of Millennium unit your are commissioning - CAV for Constant Volume and VAV for the Variable Air Volume unit.

At this point, you will see the Synthesys Configuration tool start up screen. Use this screen to enter your password. You will need the appropriate password level in order to change parameters. See the "PalmPilot Configuration Tool" chapter in this training manual for a detailed description of entering passwords.

Metric Operation (English)

The factory default for this option is OFF. The metric (SI) conversions are not a part of the controller software (application code), but are included in the software of the PalmPilot configuration tool (see User Configuration Tool description).

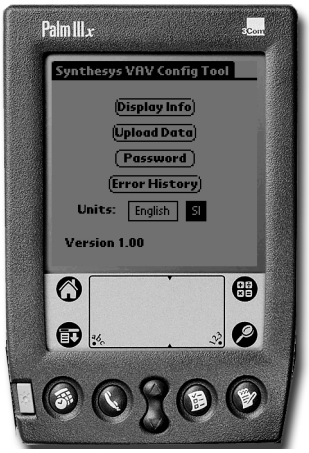


Fig 3.2: PalmPilot Start Up Screen with Metric (SI) units selected

a) Celsius Operation – All temperature sensor readings are converted to Celsius. All Temperature Setpoints are converted to degrees Celsius. All display devices will show the converted values.

b) Pascal Operation – Both the Duct Static and the Building Pressure readings and setpoints are converted from Inches of Water Column to Pascals.

c) BTU/LB Operation – Both the Outside and Return Air Enthalpy is converted from BTU/LB to kj/kg.

Upload System Data

From the Start Up screen, tap the "**Upload Data**" option. The Palm will establish communication with the controller and upload factory programmed data. A Data Hot Sync icon is displayed on the screen until the upload is complete.

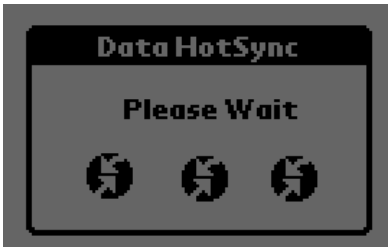


Fig 3.3: Upload Data Hot Sync Dialog

A full data upload takes about 5-10 seconds. This step is important because you should have the factory-programmed options loaded into the PalmPilot **BEFORE** attempting to change setpoints or other parameters.

Setpoints, System Critical, Service Configuration And Maintenance Screen Options

The field-programmable parameter options are found in the four configuration setup screens of the PalmPilot Synthesys COnfiguration Tool.

They are changed by highlighting the underlined "value" field on the right side and tapping the Alpha or Numeric keypad selectors

located in lower corners of the box just below the display screen.

Fig 3.4: PalmPilot Parameter Screens

You can select new parameters from the Alpha-Numeric Screen and click DONE to write the value to the PalmPilot's memory. Remember, the values are not sent to the controller until either the **SEND** or the **OK** button is touched. If you select **OK**, a dialog message will appear to remind you to send the new values to the control or they will be lost.

Palm III.x
Synthesys Setpts
Bld Press Setpt: 0.200 in w.
OccupiedCoolingSetpt: 0.000 F
Unocc. Cooling Setpt: 0.000 F
OccupiedHeatingSetpt: 0.000 F
Unocc. Heating Setpt: 0.000 F
Demand Vent. Setpt: 0.000 ppm
Hydro. Stg1 SAT Setpt: 0.000 F
Send Data?
Changes not sent to controller will be lost.
DON'T SEND SEND

Fig 3.5: Send Data Reminder Dialog.

Remember, the factory defaults may differ from those described in this section. As the unit is being manufactured, a computer will automatically program the Millennium Synthesys control with the actual parameters for the factory-installed options denoted in the unit's model number. The unit is shipped "ready-to-run". You should only need to modify some setpoints to satisfy customer requirements. Verify, however, all parameters are the correct settings for the Millennium unit your are commissioning.

The ranges or changeable options are provided. If you attempt to modify a parameter that is not with in its acceptable range, an "Entry Out of Range" dialog will appear.

Fig 3.6: Entry Out of Range Dialog

Adjustable System Parameters

The following parameter headings lists each parameter's name, screen location and its default setting. Refer to the Appendix for a quick reference of each PalmPilot Configuration Screen and the points and parameters that are found on each screen.

Compressors - System Critical (2)
This tells the control the number of compressors available. The Factory Default is 2 and can be adjusted from 1 to 4. Compressors parameter is found in the System Critical screen.

Heat Stages - System Critical (2)
This tells the control the number of heating stages available. This parameter may be set from 0 to 2. The default setting is 2 stages of heat and it is located in the System Critical screen.

Hydronic Heat - System Critical (OFF)
This tells the control that a Hot Water Coil is installed. Any time the control is going to modulate the Hot Water Valve it will also turn on the Heat one output. This is to energize the VAV heat relay for the VAV boxes. The default is OFF for this option. Hydronic Heat Enable is located in the System Critical screen. If this parameter is enabled, remember to set the Hydronic Heat First and Second Stage Setpoints and the Economizer Loading Setpoint found in the “Synthesys Setpoints” screen.

Hydronic Heat First Stage SAT Setpoint - Setpoints (130°f)
When the Hydronic Heat option is enabled, the control will maintain this SAT setpoint for a call for first stage Heating, by modulating the Hot Water Valve. This is the reset temperature when operating a VAV unit in the Heating mode. The reset range for SAT setpoint is from 80°F to 180°F with 130°F shipped as the default.

Hydronic Heat Second Stage SAT Setpoint - Setpoints (145°F)
When the Hydronic Heat option is enabled, the control will maintain this SAT setpoint for a call for second stage Heating, by modulating the Hot Water Valve. The second stage setpoint can also be adjusted from 80°F to 180°F with the factory setting at 145°F.

Economizer Loading Setpoint In Heating - Setpoints (150°f)
This is the SAT setpoint to which the SAT is controlled during 1st stage heating when the option “Economizer Loading to Control SAT” is enabled. This parameter is used only in CV application as the Economizer Loading in Heating function is not applicable to a VAV application. It must be set higher than Hydronic Heat 1st and 2nd stage Setpoints to assure that the Economizer Loading function will not cause the Economizer damper to go wide open.

SAT Control for Cooling - Service Configuration (ON)
This tells the control if it is going to do excessive SAT monitoring and tripping or not for Cooling. The SAT should be maintained in an acceptable range in order to achieve reliable compressor operation. The compressor trip limits are user adjustable between 40°F and 65°F in one degree increments. The default cooling trip limits are 50°F for stages 2-4, and 45°F for stage 1. When the SAT drops below the trip limit for each respective compressor, that compressor is locked out and a 10 minute ASCD is initiated for that compressor. SAT Control for Cooling may be found in the System Service screen. If this option is enabled, remember to set the compressor cooling limits for low limit trip. They are found in the System Critical screen.

Compressor One Cooling Limit - System Critical (45°f)
This tells the control what the low limit is for the first stage of Cooling. The adjustable range for this parameter is from 40°F to 50°F with the default value set to 45°F.

Compressor Two Cooling Limit - System Critical (50°f)
This tells the control what the low limit is for the second stage of Cooling. This limit can be

adjusted from 40°F to 65°F with 50°F set as the factory default.

Compressor Three Cooling Limit - System Critical (50°f)
This tells the control what the low limit is for the third stage of Cooling. This limit can also be adjusted between 40°F to 65°F with 50°F set as the default.

Compressor Four Cooling Limit - System Critical (50°F)
This tells the control what the low limit is for the fourth stage of Cooling. This limit is adjustable between 40°F to 65°F with 50°F set as the factory default.

Power Exhaust - System Critical (On)
This tells the control if it has the Power Exhaust option installed.

Modulating Exhaust - System Critical (Off)
This tells the control if the Power Exhaust is Modulating or not.

Exhaust Damper Position For The Exhaust Fan To Turn On (Modulating Only) - Service Configuration (80%)
This tells the control the Exhaust Damper position at which to turn on the Exhaust Fan. This value is based on the 0%-100% output drive signal from the controller to the damper actuator.

Exhaust Damper Position For Exhaust Fan To Turn Off (Modulating Only) - Service Configuration (20%)
This tells the control the Exhaust Damper position to turn off the Exhaust Fan. This value is based on the 0%-100% output drive signal from the controller to the damper actuator.

Economizer Damper Position for Exhaust Fan to turn ON (Non-Modulating Only) - Service Configuration (60%)
This tells the control the Economizer Damper position to turn on the Exhaust Fan. This value is based on the 0%-100% output drive signal from the controller to the damper actuator.

Economizer damper position for exhaust fan to turn off (non-modulating only) - service configuration (20%)
This tells the control the Economizer Damper position to turn off the Exhaust Fan. This value is based on the 0%-100% output drive signal from the controller to the damper actuator.

Building Pressure Sensor Enable - Service Configuration (OFF)
If the system does not use a Building Pressure Sensor, this option must be turned OFF to prevent alarms.

If this option is turned ON, it tells the control that use of the Building Pressure Sensor by appropriate control algorithms (e.g. control of modulating exhaust air damper, etc.) is expected, and the sensor is installed. If the sensor gets disconnected, or fails, an alarm is set. The alarm can be turned off by correcting the sensor problem (or, by turning off this option).

The control is not in this case self-configuring. It will not automatically use the Building Pressure Sensor if the sensor is connected.

If the Building Pressure Sensor is enabled and fails, i.e. the alarm “Duct Static or Bldg. Pressure Sensor failure” is set, the Power Exhaust control will default to operate as a two-position power exhaust (exhaust fan controlled as a fixed speed, On/Off fan from position of the Economizer damper) – see section

"Failure Modes and Default Operation", paragraph "Building Pressure Sensor".

Building Pressure Setpoint - Setpoints (+0.100"WG)
This is the pressure setpoint the control will maintain when operating a Power Exhaust. The Building Pressure Setpoint is adjustable from -0.200'WG to +0.200'WG. The factory programmed default is +0.100"WC.

This setpoint is used when the exhaust control is implemented as Proportional Control (with a Modulating Exhaust Air Damper controlled from building static pressure), or as a Two-position Control using building static (Power Exhaust Fan controlled on-off from building static pressure). Alternatively, the Building Pressure Setpoint can be determined by the respective dipswitch setting, if the DIP switch is enabled (i.e. the eighth dip switch is on). See Configuration DIP Switch Chart in the Appendix section.

Economizer - System Critical (ON)
This tells the control that there is an Economizer Installed.

Economizer Min Position - Service Configuration (20%)
This tells the control what the minimum outdoor damper position will be for the Occupied mode. Alternatively, the minimum position can be determined by the respective dipswitch setting for minimum position, if the DIP switch is enabled (i.e. the eighth dip switch is on). Adjustable from 0-100%, the Economizer Minimum Position default is 20%.

Economizer First Stage Setpoint - Setpoints (55°F)
This tells the control what Supply Air Temperature to maintain for a call for first stage of cooling. This is used only during Constant Volume cooling mode with Economizer operation. The setpoint is set at 55°F with an adjustable range from 40°F to 65°F.

Economizer Second Stage Setpoint - Setpoints (50°F)
This tells the control what Supply Air Temperature to maintain for a call for second stage of cooling. This is used only during Constant Volume cooling mode with Economizer operation. This setpoint is set at 50°F with a range from 40°F to 65°F.

Outside Air Humidity (OAH) Sensor Enable - Service Configuration (OFF)
This tells the control that it is expected to use Outside Air Enthalpy (calculated from Outside Air Temperature and Outside Air Relative Humidity sensed values) to decide if Outside Air can be used for cooling.

The control is self-configuring to the best available decision strategy for free cooling availability. For example, if it detects that OAT and OAH and RAT and RAH sensors are all connected and reliable, it will self-configure for Differential Enthalpy operation. If one of the return air sensors should fail, the control will reconfigure for Outside Enthalpy operation, etc.

If the OAH Sensor Enable option is turned ON, it means that the Outside Enthalpy Operation, or better decision strategy, is expected (and supported by installed sensors). If the appropriate sensors are not installed, or one of them failed, a sensor failure alarm is set. The alarm can be turned off by turning off the OAH Sensor Enable option. Thus, the option setting is used to reflect the desired operation and mainly to control sensor failure alarms. The option setting can be viewed as specifying that "the self-configured economizer decision strategy has to be at least this, or better, otherwise an alarm is set".

If the option is OFF, the control still may self-configure to Outside Enthalpy Operation, or even to Differential Enthalpy Operation (if all needed sensors are available), but this option

setting will allow also the decision strategy based on only OAT (in case other sensors fail, or are not installed) without setting an alarm.

If the controller is networked, the network can be programmed to share the OAT and OAH sensed values with other MOD UNT controllers connected to the network bus.

Outside Enthalpy Number - Service Configuration (30BTU/LB)
This tells the control an outside air enthalpy limit. Below this limit, outside air is available for cooling. See enthalpy chart. This parameter uses a one BTU/LB hysteresis on each side of the limit. The limit is preset to 30BTU/LB with an adjustable range from 22 to 40BTU/LB.

Return air humidity (RAH) sensor enable - service configuration (off)
This tells the control that it will compare Outside Air Enthalpy (calculated from Outside Air Temperature and Outside Air Relative Humidity sensed values) and Return Air Enthalpy (calculated from Return Air Temperature and Return Air Relative Humidity sensed values). The control will use the air stream with the lower enthalpy for cooling.

The control is self-configuring to the best available decision strategy for free cooling availability. For example, if it detects that OAT and OAH and RAT and RAH sensors are all connected and reliable, it will self-configure for Differential Enthalpy operation. If one of the return air sensors should fail, the control will reconfigure for Outside Enthalpy operation, etc.

If the RAH Sensor Enable option is turned ON, it means that the Differential Enthalpy Operation is expected (and supported by installed sensors). If the appropriate sensors are not installed, or one of them failed, a sensor failure alarm is set. The alarm can be turned off by turning off the RAH Sensor Enable option. Thus, the option setting is used to reflect the desired operation and mainly to control sensor failure alarms. The option setting can be viewed as specifying that “the self-configured economizer decision strategy has to be the Differential Enthalpy Operation, otherwise an alarm is set”.

If the option is OFF, the control still may self-configure to Differential Enthalpy Operation (if all needed sensors are available), but this option setting will allow a lower decision strategy without setting an alarm.

Economizer Loading to Control SAT - Service Configuration (ON)
This tells the control if it is going to use Economizer Loading to control excessive SAT. This parameter is only applicable outside the normal Economizer operation. During the Economizer operation, the loading function is always performed and is an integral part of the control algorithm.

VAV Operation with Thermostat - System Critical (ON)
This parameter is applicable only to VAV mode of operation. If this option is ON, it tells the control that a thermostat in a selected zone is used to reset SAT in cooling and to control heating. If this option is off, the control assumes that a sensor in a selected zone is used to reset SAT in cooling and to control heating and self-configures into this mode if the sensor signal is reliable. If the sensor signal is not reliable (e.g. sensor is not connected), the control will self-configure to stand-alone operation.

Duct Static Setpoint - Setpoints (1.5”WG)
This is the pressure setpoint that the control will maintain when operating the fan in a VAV unit. This setpoint is adjustable between 0”WG and 5”WG with the default set to 1.5”WG.

Duct Static High Limit Setpoint - Setpoints (4.5”WG)
This parameter is applicable only to VAV mode of operation. This tells the control at what Static Pressure to shut down the unit due to a Fan control failure. This setpoint is to insure that we don't continue to operate the Fan with an Inlet Guide Vane or VFD problem that could cause the ductwork to blow up. When the Static Pressure reaches this setpoint (4.5”WG default), the control will drive the supply fan control output to zero. If the static pressure does decrease below the “Duct Static High Limit Setpoint” within 3 seconds after decreasing the supply fan control output to zero, the control will resume normal operation. If there is no change in static pressure after 3 seconds, the control will generate a High Duct Static alarm, shut down all the outputs including the Fan and shut down the unit. The alarm is written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the alarm flag is readable by the network. This parameter can be adjusted from 0”WG to 5”WG with the factory default set to 4.5”WG.

The alarm must be reset (after the problem that caused the alarm is corrected) by resetting the MOD UNT controller (power cycle, or reset command issued by the PalmPilot Configuration Tool).

Morning Warm Up - Service Configuration (OFF)
When this option is turned ON, the Morning Warm Up feature is enabled and can be started, in a networked VAV application, by an appropriate network command. In both networked and non-networked VAV applications, the Morning Warm Up, when enabled, will also start upon all transitions from Unoccupied to Occupied mode.

Max Morning Warm Up Time Service Configuration (2Hrs)
This is the maximum time the control will conduct a Morning Warm Up. The Morning Warm Up, once started, will continue until the Occupied period begins, or until the Maximum Morning Warm Up time expires, whichever comes earlier. Morning Warm Up Time may be adjusted from 1 to 4 hours. It is set to 2 hours at the factory.

Morning Warm Up RAT Setpoint - Setpoints (70°F)
This is the Morning Warm Up Return Air Temperature Setpoint. It is adjustable from 50°F to 85°F with 70°F as default.

VAV High Temperature Setpoint for Cooling - Setpoints (60°F)
The control will maintain this SAT when operating in VAV mode with a thermostat that is calling for first stage cooling. This parameter may be adjusted from 40°F to 70°F with 60°F set as the default value.

VAV Low Temperature Setpoint for Cooling - Setpoints (55°F)
The control will maintain this SAT when operating in a VAV mode with a thermostat that is calling for second stage cooling. This parameter may also be adjusted from 40°F to 70°F with 55°F set as the default value.

VAV Setpoint for SAT Reset - Setpoints (72°F)
This parameter is used only in VAV mode with a Space Sensor. The control will switch from the VAV Low Temperature Setpoint for Cooling to the VAV High Temperature Setpoint for Cooling when this Space Temperature Setpoint minus 0.5°F is reached. The control will switch from High setpoint back to Low setpoint when the space temperature gets 2^0F above this setpoint. This is SAT reset based on Space Temperature. The reset occurs in both Occupied and Unoccupied modes and

may be adjusted from 40°F to 85°F. The factory default is 72°F.

VAV Occupied Heating - Service Configuration (OFF)
This option applies to VAV operation with a Space Sensor and does not affect VAV Occupied heating if requested by a thermostat. When this option is toggled on, a VAV unit is able to operate heating in the occupied mode as long as it is operating with a Space Sensor. If the Space Temperature drops to 2.0° F below the VAV Setpoint for SAT Reset the control will read the RAT. If the RAT is below the Morning Warm Up RAT Setpoint the unit will enter the Occupied Heating mode. Operation is the same as Morning Warm Up. This parameter is factory set to OFF.

Comfort Ventilation Mode - Service Configuration (OFF)
Comfort Ventilation is a SAT control mode that controls SAT during “satisfied” periods in a fairly wide temperature band, using mostly Outside Air, and also cooling and heating stages as necessary. It is available only on the Constant Volume unit.

To enable Comfort Ventilation, the programmable parameter “Comfort Ventilation Mode” must be set to ON (default setting is OFF). For a detailed explanation of Comfort Ventilation, refer to the Sequence of Operation in this manual.

Comfort Ventilation High Supply Air Setpoint - Setpoints (80°F)
This is the High Limit Setpoint for the Comfort Ventilation mode. For a stable operation of Comfort Ventilation function, the High Supply Air Setpoint should be set 10.0°F, or more above the Low Setpoint.

Comfort Ventilation Low Supply Air Setpoint - Setpoints (70°F)
This is the Low Limit Setpoint for the Comfort Ventilation mode. For a stable operation of Comfort Ventilation function, the Low Supply Air Setpoint should be set 10.0°F, or more below the High Setpoint.

Comfort Ventilation Max Economizer Position Service Configuration (75%)
This is the maximum Economizer position the control will use for Comfort Ventilation. This parameter is adjustable between 0 and 100%. The default is 75%.

Condenser Fan Operation - Service Configuration (2)
The rooftop unit may have one, or two condenser fans installed. The control will command the two condenser fan control binary outputs in sequence, regardless of whether the second condenser fan is installed, or not.

Option = 1 - The condenser fan outputs will operate with the compressors. When compressor number one is turned on, turn on condenser fan output number one. When compressor number two is turned on, turn on condenser fan output number two.

Option = 2 - Turn on all the condenser fan outputs with any compressor.

Option = 3 - Turn on condenser fan output number one with compressors one and two. Turn on condenser fan output number two with compressors three and four.

Dirty Filter Switch - Service Configuration (ON)
This tells the control that a Dirty Filter Switch is connected to it. The control will wait for one minute after the switch has closed before declaring a Dirty Filter Alarm. The alarm is written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the error flag is readable by the network. The alarm will automatically reset when the error condition is corrected.

(Note that the Dirty Filter switch uses input previously used alternatively by Freeze Stat 3 and Dirty Filter Switch. The Freeze Stat 3 is not used). The default is ON.

Heating Lockout on OAT - Service Configuration (75°F)
This is the Outside Air Temperature Setpoint that the control will use to lock out Heating when the OAT is above this setpoint. Use a one-degree hysteresis on each side of the setpoint. This parameter is adjustable between 0°F and 100°F with the default set to 75°F.

Heating Lockout on OAT affects only staged heating, it does not affect hydronic heat. If the heating is energized when OAT reaches this setpoint, the Status LED will indicate the lockout condition immediately, but the control will finish the heating mode and then lock out the heating.

Note that a Heating Lockout on OAT may occur while the control is in a heating mode and there is a demand for heating. If the OAT then decreases below the lockout setting while the call for several heat stages exists, the heat stages will turn on simultaneously. This is considered acceptable as this situation is not expected to occur frequently.

Cooling Lockout on OAT - Service Configuration (45°F)
This is the Outside Air Temperature Setpoint that the control uses to lock out Cooling when the OAT is below this setpoint. Adjustable from 0°F to 100°F, the default is 45°F.

Unoccupied Heating Setpoint - Setpoints (60°F)
This value is the Unoccupied Heating Setpoint. It is used in both CV and VAV mode of operation (in VAV, it controls Unoccupied heating with a Space Sensor). The PalmPilot User Configuration tool software will treat the Occupied and Unoccupied heating and cooling setpoints as a parameter group and will assure that the values entered by you are correctly related to each other, i.e in an ascending sequence as illustrated below:

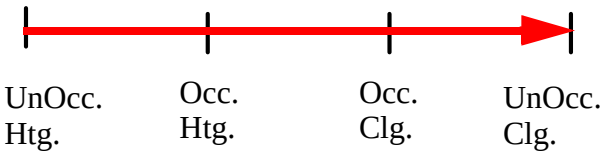


Fig 3.7: Sequence of Setting the Setpoints

Unoccupied Cooling Setpoint - Setpoints (85°F)
This value is the Unoccupied Cooling Setpoint. It is used in both CV and VAV mode of operation (in VAV, it controls Unoccupied cooling with a Space Sensor). Its relationship to the related setpoints is as defined in the Unoccupied Heating Setpoint paragraph above.

Occupied Heating Setpoint - Setpoints (68°F)
This value is the Occupied Heating Setpoint. It is used only in CV mode of operation. Its relationship to the related setpoints is as defined in the Unoccupied Heating Setpoint paragraph above.

Occupied Cooling Setpoint - Setpoints (72°F)
This value is the Occupied Cooling Setpoint. It is used only in CV mode of operation. Its relationship to the related setpoints is as defined in the Unoccupied Heating Setpoint paragraph above.

Freeze Thermostats - System Critical (0)
This number tells the control how many Freeze Thermostats are connected to it. The range is 0-2 with) = Disable

FZR (Hot Water Freeze Protection) - System Critical (OFF)
This option is used only on rooftop units with hydronic heat (Hydronic Heat Option is turned ON). When this option is enabled, it tells the control that the input normally used to accept a LAR jumper, used to detect if a Low Ambient Kit is installed, is now a Hot Water Coil Freeze switch input. Freeze protection should always be placed on units that use hydronic heating.

Supply Air Alarm Setpoint for Cooling - Service Configuration (0°F)
The SAT must drive below this setpoint when all stages of compression are operating and 10 minutes has elapsed since the last compressor was energized. If this does not happen, the control will declare a Cooling SAT Failure Alarm.

The alarm is written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the alarm flag is readable by the network.

The alarm will reset automatically if the SAT does decrease below the setpoint (the alarm condition no longer exists), or when a compressor is turned off (the control does not request all compressors to operate).

The SAT Alarm Setpoint for Cooling can be adjusted from 50°F - 80°F. If the value is set to 0°F (default) this feature is disabled.

Supply air alarm setpoint for heating - service configuration (0°f)
The SAT must drive above this setpoint when all stages of heating are operating and 10 minutes has elapsed since the last stage was energized. If this does not happen, the control will declare a Heating SAT Failure Alarm.

The alarm is written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the alarm flag is readable by the network.

The alarm will reset automatically if the SAT does increase above the setpoint (the alarm condition no longer exists), or when a heating stage is turned off (the control does not request all heat stages to operate).

The SAT Alarm Setpoint for Cooling can be adjusted from 70°F - 120°F. If the value is set to 0°F (default) this feature is disabled.

Unoccupied Override Time Limit - Service Configuration (60 min)
The Unoccupied Override function and the associated Time Limit is used only in Constant Volume systems. The value programmed here will determine how long the unit will operate in the Unoccupied Override mode when the Override button is pressed on the Space Sensor.

Once the Unoccupied Override mode is initiated, it will continue until the programmed Unoccupied Override Time Limit is reached. The Override mode can not be cancelled by, for example, a change of state of the Occupied input to ON (occupied) and then back to OFF (unoccupied).

This parameter is adjustable from 0 to 240 minutes. The default is 60 minutes.

Fan Overrun (ON)
When this option is turned ON, the Fan will, on transition from a cooling to a satisfied state, continue to run for 60 seconds.

Fan ON Mode with the Sensor Option - Service Configuration (ON)
When this option is turned ON, the supply fan will continue running when the zone sensor

based temperature control is satisfied. This option applies only in systems using a zone sensor and only in Occupied mode. With this option turned OFF, or in Unoccupied mode, the fan will go off when the zone sensor based temperature control is satisfied and will go on only when there is a call for heating or cooling. Turning this option ON is an equivalent of selecting fan ON (rather than AUTO) in systems with a thermostat. In a thermostat system, the fan control follows the thermostat's G signal. In sensor systems and in the Occupied mode, the fan control follows the Fan ON Mode option.

Space Sensor Enable - Service Configuration (OFF)
This option is used differently in CV and in VAV applications:

CV application: If the option is OFF, the Space Sensor function is disabled, the control will only operate the unit from the Thermostat inputs. If this option is turned ON, the function of the Space temperature Sensor is enabled and a related Space Sensor Failure Alarm is enabled. If the sensor is not connected, or fails, an alarm is set. The alarm can be turned off by turning off this option.

If the Space Sensor fails, i.e. the Space Sensor failure alarm is set, the control will use the RAT sensor as a backup - see the next paragraph on RAT Sensor Enable.

The control is in this case not self-configuring, i.e. it will not automatically use the Space Sensor if connected. If the sensor is connected, it still must be enabled by turning this option ON.

VAV application: The option setting only enables, or disables the Space Sensor Failure Alarm, not the actual Space Sensor function. The actual Space Sensor function is enabled by setting OFF a programmable option "VAV Operation with Thermostat". When the Space Sensor function is enabled, the control self-configures to a VAV operation with a Space Sensor if the sensor is available, to stand-alone operation if the sensor is not available.

RAT Sensor Enable - Service Configuration (OFF)
If this option is turned ON, it means that use of the RAT sensor by appropriate control algorithms is expected, the sensor is installed. If the sensor is not connected, or fails, an alarm is set. The alarm can be turned off by turning off this option. Thus, the setting of this option is used to reflect the desired operation and mainly to control sensor failure alarm.

The control is self-configuring, and will detect the RAT sensor if it is connected and use this sensor to control Morning Warm Up in a VAV application. The control will also use this sensor as a backup if the Space Sensor fails so that the unit can operate in a default mode until someone can repair the failed Space Sensor.

If the option is OFF, the control still may self-configure to use the RAT sensor, but this option setting will allow operation without this sensor without setting an alarm.

Demand Ventilation Setpoint - Service Configuration (1000ppm)
This Setpoint is the maximum Indoor Air Quality (IAQ) level that the control will allow. It is adjustable from 700ppm to 1500ppm.

Max Economizer Position for Demand Ventilation - Service Configuration (50%)
This is the maximum outdoor damper position the control will allow while operating in the Demand Ventilation mode. It is adjustable from 0-100%.

IAQ Sensor Range - Service Configuration (5,000ppm)
This tells the control what the full range is for a specific IAQ sensor. It can be changed from 0 to 10,000ppm.

Alarm Input- System Critical (OFF)
This tells the control that FS1 (Freeze 'Stat input #1) is used as an alarm input. When 24vac is detected at FS1 the control will generate an Alarm that will tell you that the unit has a compressor locked out. No other control action is taken. The alarm is written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the alarm flag is readable by the network. The alarm is automatically reset when the error condition no longer exists. This option is used when the control is connected to the terminal strip and not integrated in the unit.

Low Ambient Kit Installed - System Critical (OFF)
This tells the control that a Low Ambient Kit is installed. The control can operate cooling down to 0°F OAT. The change to 0°F applies only to compressors # 1 and # 2 (the Low Ambient Kit affects only operation of these two compressors). This option (or the equivalent, when LAR jumper is installed) takes priority over the OAT for cooling lockout.

When this option is enabled, the control will not need to read the LAR input to see if the Low Ambient Kit is installed and Low Ambient Operation is allowed. This option has to be turned on to enable Low Ambient Operation in case the LAR input is used for another purpose - to connect an optional Hot Water Coil Freeze Switch on units with hydronic heat.

Cooling Mode Enable Service Configuration (ON)
This tells the control if it has Cooling Available (Mode Switch). If this option is turned off, cooling operation is disabled. Note that this parameter does not affect cooling operation in Comfort Ventilation mode.

Heating Mode Enable - Service Configuration (ON)
This tells the control if it has Heating Available (Mode Switch). If this option is turned off, heating operation is disabled. Note that this parameter does not affect heating operation in Comfort Ventilation mode.

Space setpoint offset - service configuration (3°f)
The Space Setpoint Offset is the +/- value the control will use to offset the Space Setpoint when the slidebar Space Sensor is used. For example, if the Space Setpoint Offset value is set to 3.0°F, shifting the slidebar all the way in minus direction will decrease the Space Setpoint by 3.0°F and shifting it all the way in plus direction will increase the Space Setpoint by 3.0°F. It is adjustable from 0°F to 5°F.

Two Compressors per Circuit (OFF)
This tells the control that it will use Compressor Status input number one for compressors number one and two and it will use Compressor Status input number two for compressors number three and four. This is for the dual compressor setup, where two compressors share the same refrigeration circuit and safety chain switches and a freeze 'stat. This is a typical configuration for 25 Ton VAV units.

In initial application code implementation, both compressors of the dual compressor setup is controlled by the same controller output. Therefore, the two compressors are, from the viewpoint of the controller, controlled as one, the dual compressor setup is only reflected in the appropriate control wiring for

the compressors and the "Two Compressors per Circuit" option is not utilized.

The option is expected to be utilized in later revisions of the application code, when the two compressors are expected to be controlled by separate controller outputs to allow additional flexibility in staging.

ASCD Override - Service Configuration COMMANDS

This is not an option parameter but rather a one-time command issued by the PalmPilot configuration tool. This command can be found by tapping the COMMANDS button in the Service Configuration screen. This command can also be issued by toggling #6 switch of the Configuration DIP Switch, but only if the DIP switch is enabled (i.e. its #8 switch set to ON).

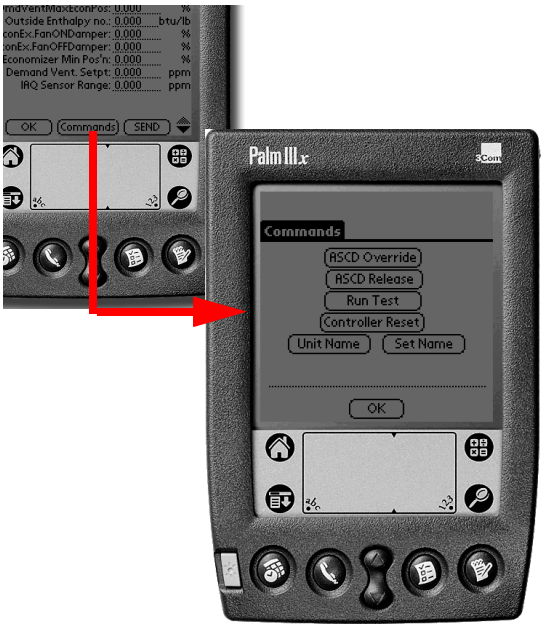


Fig 3.8: Service Configuration Screen - COMMAND

When this command is issued, the control will read all the compressor's Anti Short Cycle Delay's. If any of them are loaded with more than 30 seconds, the control will load 30 seconds in them.

After the ASCD Override command is issued and takes effect, it should be reset by the operator - the DIP switch should be toggled back to Off position, and/or on the PalmPilot configuration tool, a corresponding command "ASCD Release" should be used. If this is not done, the ASCD Override command times-out automatically after 10 minutes, but can not be used again until the appropriate reset is done.

Run Test (Commissioning Test) - Service Configuration COMMANDS

This is not an option parameter but rather a one-time command issued by the PalmPilot configuration tool. This command can be accessed by tapping the COMMANDS button in the Service Configuration screen. This command can also be issued by toggling #7 switch of the Configuration DIP Switch, but only if the DIP switch is enabled (i.e. its #8 switch set to ON). If the switch #7 is left in its ON position, rather than toggled On / Off, the control will still run only a single Run Test sequence. However, the switch will have to be returned to its Off position before it can be used to initiate another Run Test sequence. When the Run Test command is issued, the control will shut the unit down if it is running and then start a Run test sequence:

1) Turn on the Fan and then turn on all the compressors, one at a time, with a 30-second delay between them. Condenser fan #1 turns on with compressor #1, condenser fan #2 turns on with compressor #2. After the last compressor has been turned on, the control will run the compressors for three minutes and then turn them all off. Condenser fans are also turned off.

2) The control will then turn on the Heat stages, one at a time, with a one-minute delay between them. After the last Heat stage has been turned on, the control will

run the Heat for three minutes and then turn all the Heat off.

3) The control will then open the Economizer to the 100% open position and wait three minutes before closing it to the Minimum Position.

4) During this Run Test operation the control will read all the installed sensors and verify that their readings are good. If any error is detected the control will flash the appropriate error. During the Run Test, the supply fan continues to be monitored via the Air Proving Switch, and a fan failure will cause a unit shutdown.

After the control is finished with the Run Test the normal operation will resume. This command is a good method to use to ensure the control is operating and all input and output points are functional.

Controller Reset - Service Configuration Commands

This command is not an option parameter but rather a one-time command issued by the PalmPilot configuration tool. The Controller Reset is used to clear faults such as a Fan Failure by resetting the controller. A reset sequence will halt all control action and shut down all outputs. The control will then restart all control actions using appropriate ramp up PI algorithms to resume normal operation.

Notes

Chapter 4: Sequence of Operation for Synthesys Controls

This chapter describes the many control modes of operation for Synthesys. Because of the narrative and detailed descriptions contained in this section, you should only scan this chapter and become familiar with the primary topics. Then, use this chapter as a reference whenever a more detailed understanding of a particular mode is needed.

Several control modes will override other modes of operation. For example, The Demand Ventilation (or Indoor Air Quality) control may override Comfort Ventilation and Economizer control and drive the OA dampers above the established minimum position. The Excessive SAT control will override all temperature control modes, Economizer mode, and compressor operation as well. If you suspect that a problem exists with the economizer, or the compressors are locked out when no alarms are set, verify that one of the control modes is not overriding the normal mode of operation or the operation you might expect to see. Another important example is the Air Proving Switch interlocking mode. If the fan status fails, all controlling algorithms and operations, and outputs (except hydronic heat) will cease and the control will shut down all outputs.

You should keep in mind that, especially with digital controls, interlocking between control modes is common and easily achieved. Also, by the vary nature of digital control programming, many types of controls can be implemented because they generally require only software programming and very little peripheral hardware. This reduces the costs associated with manufacturing and servicing the equipment.

4.1 Air Proving Switch

In CV operation, with a thermostat or a space sensor, the control will start the supply fan and wait for the Air Proving Switch to close before it allows a cooling, or heating stage to be energized (se CV Operation section). When the control turns on the fan it will wait 75 seconds and then read the Air Proving Switch. If the switch is not closed after the 75-second delay, or while operating the supply fan and the switch opens for 15 seconds, the control will shut down all outputs and declare a Fan Failure Alarm. The alarm is written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the alarm flag is readable by the network. The alarm must be reset (after the problem that caused the alarm is corrected) by resetting the MOD UNT controller (power cycle, or reset command issued by the PalmPilot Configuration Tool).

For a detailed description of Error History Buffer, Failure Alarm Handling, and Screen Snapshots see the Trouble Shooting section of this manual.

If at any time the control reads the Air Proving switch closed when the fan has been off for 5 minutes, it will declare a bad Air Proving Switch error, but continue to operate the unit. This failure mode of the Air Proving Switch can only be detected with the Supply Fan off. It is important to detect because it effectively disables the fan failure alarm checking while fan is running, described in the paragraphs above. Those checks would always pass as the switch would remain closed. The error is written to the Error History Buffer and will trig-

ger storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the error flag is readable by the network. The alarm will automatically reset after the problem that caused it has been corrected.

4.2 Comfort Ventilation Mode

Comfort Ventilation is a SAT control mode that controls SAT during “satisfied” periods in a fairly wide temperature band, using mostly Outside Air, cooling and heating stages as necessary.

Comfort Ventilation is applicable in CV equipment configurations where there is space (zone) temperature sensing and control. It is implemented in CV operation with thermostat, or space sensor.

Without using the Comfort Ventilation mode in such equipment configurations, when the space temperature control loop is satisfied (zero demand), all cooling and/or heating stages would be turned off and the SAT would be allowed to float until the space temperature control loop again generates a call for cooling, or for heating. The supply fan may be kept on during the “satisfied” periods, or may be turned off, depending on thermostat settings, or “Fan ON mode with the Sensor” option setting.

The Comfort Ventilation is used to optionally replace the uncontrolled, floating SAT situation during the “satisfied” periods with a “loose” SAT control in a fairly wide temperature band (between specified Comfort Ventilation High Supply Air Setpoint and Comfort Ventilation Low Supply Air Setpoint). This may require some additional energy, but improves space comfort (e.g. instead of bringing a very hot and humid ventilation / outdoor air into space during the “satisfied” periods, the ventilation air temperature is “trimmed” to be within the specified SAT control band). Comfort Ventilation mode terminates when there is a call for heating or cooling from the space temperature control.

✔ Comfort Ventilation can be used only on units equipped with an Economizer.

✔ Comfort Ventilation only operates in an Occupied mode.

✔ “Comfort Ventilation Mode” must be set to ON (default setting is OFF).

Comfort Ventilation mode, when selected, will during the “satisfied” periods, when there is no call for heating or cooling, take priority over supply fan control and keep it running.

The Comfort Ventilation utilizes Outside Air and controls the Economizer as needed whenever the SAT deviates from the specified temperature band. When the SAT control with Outside air is insufficient, it will utilize an appropriate amount of heating or cooling stages in addition to control with Outside air.

The modulating range of the economizer dampers are limited by a specified Economizer Minimum Position and by a specified Comfort Ventilation Maximum Economizer Position.

The Economizer capability to control SAT may be further limited in case the Demand Ventilation Operation is enabled and overrides the Economizer position more open in order to satisfy space IAQ requirements.

The values of “Comfort Ventilation High Supply Air Setpoint” and “Comfort Ventilation Low Supply Air Setpoint” would typically be set such that they are centered around an expected return air temperature. The band between the two setpoints should be set wide enough so that SAT changes due to staging /

destaging compressors, or heating stages, can be compensated for by the economizer control such that staging / destaging is minimized. Also, a wider band minimizes use of additional energy during unit's "satisfied" periods.

Economizer Control During Comfort Ventilation

Economizer control uses a Proportional-Integral control algorithm that maintains SAT within the specified SAT band by repositioning the economizer dampers. The PI algorithm setpoint is calculated as a midpoint between the programmed "Comfort Ventilation High Supply Air Setpoint" and "Comfort Ventilation Low Supply Air Setpoint". As the controller uses outside air to maintain the SAT at the setpoint, it must be capable of self-configuration for Direct, or Reverse action, depending on the relationship of the OAT to the specified SAT control band:

- If the OAT is below the specified SAT band low setpoint ("Comfort Ventilation Low Supply Air Setpoint"), the action is Direct Acting. In this case, the economizer control can lower the SAT temperature just by opening the economizer damper and using more outdoor air. However, if the economizer algorithm can not prevent the SAT from dropping below the bottom control band limit by closing the economizer damper to its programmed minimum position, one or more heating stages may need to be turned on. Similarly, if the economizer algorithm can not prevent the SAT from increasing above the top control band limit by opening the economizer damper to its programmed "Comfort Ventilation Maximum Economizer Position", one or more compressors may need to be turned on

- If the OAT is above the specified SAT band high setpoint ("Comfort Ventilation High Supply Air Setpoint"), the action is Reverse Acting. In this case, the economizer control can increase the SAT temperature just by opening the economizer damper and using more outdoor air. However, if the economizer algorithm can not prevent the SAT from increasing above the top control band limit by closing the economizer damper to its programmed minimum position, one or more compressors may need to be turned on. Similarly, if the economizer algorithm can not prevent the SAT from dropping below the bottom control band limit by opening the economizer damper to its programmed "Comfort Ventilation Maximum Economizer Position", one or more heating stages may need to be turned on

- If the OAT is within the SAT control band, i.e. between the programmed "Comfort Ventilation High Supply Air Setpoint" and "Comfort Ventilation Low Supply Air Setpoint", the economizer damper is overridden to fully open position. In this case, no other control action needs to be taken to maintain the SAT within the specified control band

Staging Control During Comfort Ventilation

The economizer control alone may not be able to maintain the SAT within the specified control band. A separate staging control algorithm supplements the economizer control and will stage heating, or mechanical cooling as necessary.

If the SAT increases above the "Comfort Ventilation High Supply Air Setpoint" for more than 5 minutes, the control will destage a heating stage (if any heating stages running), or add a compressor. Repeat this every 5 minutes until the SAT gets back to within the control band.

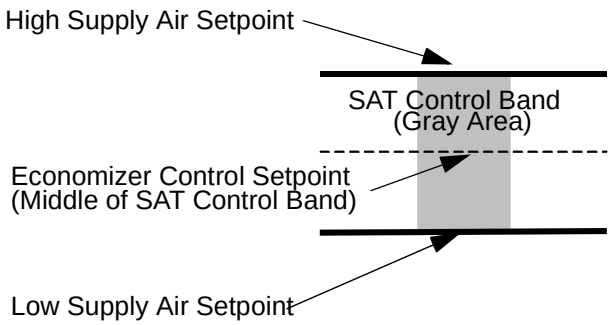


Fig 4.1: Comfort Ventilation Economizer Control

If the SAT drops below the "Comfort Ventilation Low Supply Air Setpoint" for more than 5 minutes, destage a compressor (if any compressors running), or add a heating stage. Repeat this every 5 minutes until the SAT gets back to within the control band.

As the heating stages, or compressors are staged up, or destaged, the economizer controls continues using the economizer damper to "trim" the effect of the staging and to maintain the SAT as near the middle of the SAT control band as possible.

If the unit is using hydronic heat, the control modulates the water valve to maintain SAT at the programmed "Comfort Ventilation Low Supply Air Setpoint". At this setpoint, the hydronic heat control does not conflict with the economizer control, and will prevent SAT from dropping outside of the specified control band when the economizer can no longer maintain the SAT at its middle-of-the-band setpoint.

4.3 Hydronic Heat

Any time the control is going to modulate the Hot Water Valve it will also turn on the Heat one output. This is to energize the VAV heat relay for the VAV boxes. The default is OFF for this option.

The Hydronic Heat option requires a SAT sensor that can sense SAT in heating mode (a sensor placed downstream of the heating coil).

The SAT sensor that is factory-installed can be used for cooling mode only. To use the SAT sensor in both heating and cooling modes it has to be relocated, or replaced by a field installed sensor.

During hydronic heating, the SAT control to the selected “Hydronic Heat First Stage SAT setpoint”, or “Hydronic heat Second Stage SAT Setpoint” is performed using a Proportional/Integral control algorithm. The control algorithm includes special provisions (sometimes referred to as a “bumpless transfer” feature) that allow it to resume control of SAT as fast as possible when it is re-activated during the ON / OFF cycling of the unit (cycling between a satisfied and a heating state under control of a zone thermostat, or zone sensor). In its OFF-state, the control algorithm continues monitoring the SAT and performs calculations necessary to set its output, that controls the hot water valve, to have the same value on starting the ON-cycle as it had when it went into the OFF-cycle (in spite of some decrease in the SAT during the OFF-cycle).

The “bumpless transfer” feature of the hydronic heat control algorithm essentially acts similar to a “memory” that holds the algorithm output during the OFF-cycles. This “memory” is reset only on unit shutdown. The effect of this “memory” can be observed on the action of the hot water valve. After unit startup (during the first ON-cycle of the hydronic heat), there is no “memorized” output value and the valve moves relatively slowly into a control position required to maintain the SAT setpoint. On subsequent ON-cycles, the valve moves into a control position much faster as dictated by the output value stored in control algorithm “memory”.

4.4 Cooling Lockout on OAT

This is the Outside Air Temperature Setpoint that the control uses to lock out mechanical cooling when the OAT is below this setpoint. There is a one-degree hysteresis on each side of the setpoint. Adjustable from 0°F to 100°F, the default is 45°F.

When the Low Ambient Resistor (LAR) is installed, the setpoint will default to 0°F. The change to 0°F applies only to compressors # 1 and # 2. The LAR (or the equivalent, when option "Low Ambient Kit Installed" is set ON) takes priority over the OAT for cooling lockout.

If the cooling is energized when OAT reaches this setpoint, the Status LED will indicate the lockout condition immediately, but the control will finish the cooling mode and then lock out the cooling.

Cooling Lockout on OAT may occur while the control is in an Economizer mode and there is a demand for compressors. If the OAT then increases above the lockout setting while the call for several compressors exists, the compressors will turn on simultaneously. This is considered acceptable in this case as this situation is not expected to occur frequently.

4.5 FZR (Hot Water Freeze Protection)

This option is used only on rooftop units with hydronic heat (Hydronic heat option is turned ON). When this option is enabled, it tells the control that the input normally used to accept a LAR jumper, used to detect if a Low Ambient Kit is installed, is now a Hot Water Coil Freeze switch input. It is expected that the Hot Water Freeze Protection Switch is installed on all units that use hydronic heat. When this switch opens, the control will open the Hot Water valve to 100%. The control will continue to drive the valve at 100% until five minutes after the switch has closed. This control sequence takes place regardless of the supply fan status (it is expected to be used/needed mostly in situations when the supply fan is not running). A Hot Water Coil Freeze Alarm is generated. The alarm is written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the alarm flag is readable by the network. After the valve override sequence described above is completed, the valve will revert to normal operation and the alarm is automatically reset. The same sequence is repeated every time the Hot Water Coil Freeze Switch opens (infinite retries). However, the subsequent alarms do not trigger storage of additional "error data snapshots" (see also section "Failure Modes and Default Operation", paragraph on "Handling of persistent errors, repeated errors and multiple errors" in the Trouble Shooting section).

When this option is turned ON, ensure that the hardware (Hot Water Coil Freeze Switch) is properly connected to the controller (otherwise, the unit may run infinite retries on water valve).

Note: turning this option ON effectively disables the LAR jumper function. You must make sure that the Low Ambient Operation is not needed, or, if it is, that the "Low Ambient Kit Installed" option is turned ON.

CV AND VAV APPLICATIONS IMPLEMENTED SEPARATELY

The application code for controlling Constant Volume rooftop unit is implemented separately from the application code for controlling Variable Air Volume rooftop unit. There are two controller models (CV and VAV controllers) that are identical in hardware and firmware and differ only in the application code downloaded into the controller, and in the

appropriate labeling. The PalmPilot User Configuration Tool software is also developed as two separate applications (CV and VAV Configuration Tool). The CV Configuration tool software is usable only with a CV controller and VAV Configuration tool is usable only with a VAV controller.

4.6 CV Operation

The paragraphs below identifies control modes of CV operation and provides an overview of control methods in all modes. The modes include Occupied and Unoccupied Heating and Cooling and differ depending on the method used to control zone temperature (thermostat, or a space sensor). The heating vs. cooling modes are entered under control of the thermostat, or, in case of space sensor, by control algorithm detecting zone cooling, or heating demand. The "occupied" vs. "unoccupied" modes are controlled by a signal generated by the thermostat, or by an external "Occupied/Unoccupied" signal source (such as a time clock). If a thermostat is connected in addition to the space sensor, it takes priority over the space sensor.

4.6.1 THERMOSTAT OPERATION FOR COOLING WITH Y1 AND Y2 INPUTS

When stage-one and stage-two outputs are de-energized, and only when the option "Fan Overrun" is set to ON, the Fan output will continue for 60 seconds even if the G input becomes inactive along with Y1 and Y2. If G does not terminate, the controller wil continue to operate the Fan.

A Minimum run time of three minutes applies to all compressors. The minimum run time is necessary to ensure that the oil in the refrigerant circuit circulates back to the compressor. The ASCD delay of five minutes (nominal) applies any time compressor operation is terminated.

The actual minimum off times for individual compressors differ by 10 seconds in order to prevent compressors from turning on simultaneously during certain control mode transfers:

Table 1:

Compressor:	Min. off time:
#1	4 min. 40 sec
#2	4 min. 50 sec
#3	5 min. 00 sec
#4	5 min. 10 sec

Grouping compressors into stages

On two compressor units, compressor one is first stage and compressor two is second stage. On three compressor units, compressors one and two are first stage and compressor three is second stage. On four compressor units, compressors one and two are first stage and compressors three and four are second stage. On five compressor units, compressors one, two, and three are first stage and compressors four and five are second stage. On six compressor units, compressors one, two, and three are first stage and compressors four, five, and six are second stage. There is a five-minute delay (cooling interstage delay) between stage-one and stage-two operation.

Economizer mode

In CV cooling with a thermostat and when free cooling is available ("economizer suitable"), the SAT is controlled by the economizer control algorithm (see section Economizer Operation later in this manual) and the thermostat determines (by 1st and 2nd stage calls) the active economizer SAT setpoint. When the thermostat is satisfied (Y1=OFF, Y2=OFF), then the unit either shuts down (in case G=OFF) after the specified supply fan overrun time, or only the supply fan continues to operate (in case G=ON). The operation of the thermostat's G signal is

determined by the thermostat's fan mode switch (AUTO, or ON fan mode).

Note that during Economizer operation using "Economizer First Stage Setpoint" for SAT control, one or more compressors may be running in addition to economizer damper partially, or fully open to provide free cooling. The amount or compressors running will mainly depend on outdoor air temperature. Therefore, when the thermostat is satisfied and shuts down the cooling, it may be turning off more than one compressor (after compressor minimum run time expires). This is acceptable and is not expected to occur frequently. If the outdoor air condition is such that more than one compressor is needed in addition to free cooling, the Economizer mode is likely to terminate and the unit will switch over to mechanical cooling only.

4.6.2 THERMOSTAT OPERATION FOR HEATING WITH W1 AND W2 INPUTS

W1 and W2 inputs for a YAC and a PAC: YAC is a Year Around Air Conditioner and is equipped with a "gas pack" (gas heating). PAC is a Packaged Air Conditioner and is equipped with electric heat.

Supply fan overrun

When the W1 and W2 outputs are de-energized, the fan output will continue until the SAT drops below a specified limit. The limit is 100° F and there is a 5° F differential to prevent fan cycling, i.e. the fan will go off when the SAT drops below 95° F. Use this sequence even if G becomes inactive along with W1 and W2. If G does not terminate, continue to operate the Fan.

Heat Stage Delays

Two minute Minimum Run Time and ASCD delays of two minutes applies to all heat stages. Also, there is a delay between W1 and W2 outputs of at least one minute (Interstage Delay for Heating).

Thermostat Operation with Hydronic Heat

The zone thermostat makes a selection between satisfied state (both W1 and W2 off), heating using a programmed "Hydronic Heat 1st Stage SAT Setpoint" (W1 is on, W2 is off), or heating using a programmed "Hydronic Heat 2nd Stage SAT Setpoint" (both W1 and W2 are on). During heating, the SAT control to the selected SAT setpoint is performed using a PI algorithm.

Sensor Operation:

Typically, only a thermostat, or only a space sensor would be installed. However, there are cases where both could exist. One such case is servicing or troubleshooting the unit. A service person will typically hardwire the thermostat inputs to check the equipment operation even if the unit is using a space sensor. The thermostat input will have priority over the Space Sensor. A unit using a space sensor will switch to a thermostat control strategy automatically if a thermostat input is detected and switch back if the thermostat is no longer detected.

Types of Space Sensors

No Sensor- the option Space Sensor Enable is OFF. The Control will only operate the unit from the Thermostat inputs.

Thermistor Only - This Sensor only has a Thermistor in it for unit operation.

Sensor with Unoccupied Override Button - This Sensor has a Thermistor and an Override button that shorts the Sensor when pushed. After the Override button has been pushed for a minimum of one second the unit will go into the Unoccupied Override mode for the Unoccupied Override Time (note that the control must not recognize the short as a sensor failure). Once the Unoccupied Override mode is initiated, it will continue until the programmed Unoccupied Override Time Limit is reached

Sensor with Space Setpoint Adjust - This Sensor has a slider potentiometer on it that represents (as a default) +/- 3°F adjustment to the Space Setpoint. The Space Setpoint Offset option. This point is not visible on the PalmPilot. If the unit appears to be controlling at a higher or lower temperature than the setpoint, check the Space Setpoint Adjust slider.

Supply Fan Control When Using A Zone Sensor

In the Occupied mode, setting of the parameter "Fan ON mode with the Sensor Option" will determine if the Supply Fan is ON continuously, or is in "Auto" mode (i.e. cycles with the heating/cooling cycles). In Unoccupied mode, the fan is always in the Auto mode.

Supply fan overrun

In heating operation with a zone sensor, when the zone temperature control algorithm is satisfied and the last heating stage is turned off, the fan output will continue until the SAT drops below a specified limit. The limit is 100°F and there is a 5°F differential to prevent fan cycling, i.e. the fan will go off when the SAT drops below 95°F.

In cooling operation with a zone sensor, when the zone temperature control algorithm is satisfied and the last compressor is turned off, and only when the option "Fan Overrun" is set to ON, the fan output will continue for 60 seconds.

Control of compressors when using a zone sensor

A Minimum run time of three minutes applies to all compressors. The minimum run time is necessary to ensure that the oil in the refrigerant circuit circulates back to the compressor. The Anti Short Cycle delay of five minutes applies any time compressor operation is terminated.

Compressors are turned On and OFF individually during CV operation with a zone sensor, where the cooling control algorithm is implemented in the controller (rather than in a thermostat). The stage groups are applicable only for control of compressors with external signals, such as from a thermostat.

There is a minimum one-minute delay between compressors when bringing on multiple compressors.

Heating Operation with the Sensor Option

The space temperature is controlled to a programmed Unoccupied Heating Setpoint, or to a programmed Occupied Heating Setpoint, as determined by the state of the Occupied Input (if this input is OFF, the unit is in Unoccupied mode).

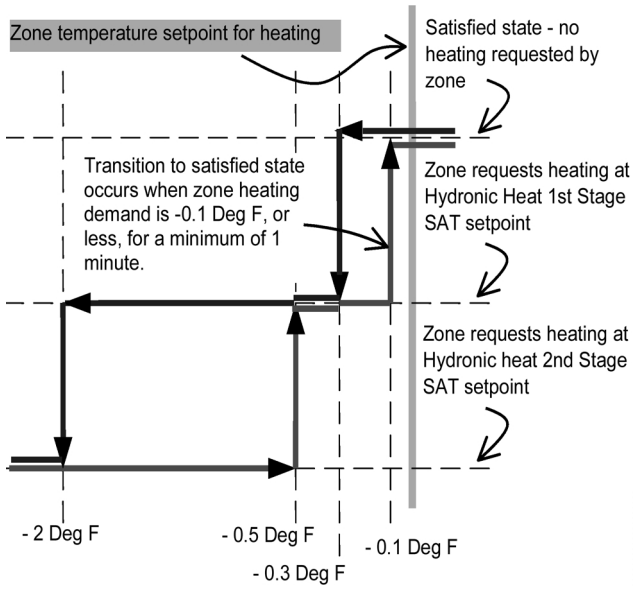

Zone temperature setpoint for heating
Satisfied state - no heating requested by zone
Transition to satisfied state occurs when zone heating demand is -0.1 Deg F, or less, for a minimum of 1 minute.
Zone requests heating at Hydronic Heat 1st Stage SAT setpoint
Zone requests heating at Hydronic heat 2nd Stage SAT setpoint
- 2 Deg F
- 0.5 Deg F
- 0.3 Deg F
- 0.1 Deg F

Fig 4.2: Heating Control Algorithm

A zone heating demand of -0.3°F, or more, will generate a request for hydronic heat with the programmed "Hydronic Heat 1st Stage SAT Setpoint". A zone heating demand of -2°F, or more, will generate a request for hydronic heat with the programmed "Hydronic Heat 2nd stage SAT Setpoint". The diagram above shows the differential used for switching between the 1st and 2nd stage SAT setpoints.

When the zone temperature is -0.1°F, or less below the zone setpoint for at least 1 minute, the transition to a satisfied state occurs, the heating stops and the supply fan either continues running, or is turned off after SAT drops below 100°F. The supply fan control in the satisfied state and in the occupied mode is determined by setting of the programmable parameter "Fan ON Mode with the Sensor Option". In the unoccupied mode, the fan is always turned off when the zone is satisfied.

During heating, the SAT control to the selected SAT setpoint is performed using a PI algorithm. Two minute Minimum Run Time and Anti Short Cycle delays applies to all heat stages. There is also a delay of at least one minute between turning on heating stages.

Cooling Operation with the Sensor Option
The space temperature is controlled to a programmed Unoccupied Cooling Setpoint, or to a programmed Occupied Cooling Setpoint, as determined by the state of the Occupied Input (if this input is OFF, the unit is in Unoccupied mode).

The cooling state is entered and the control algorithm activated when zone cooling demand is +0.3°F, or more. The algorithm is deactivated and the control returns to satisfied state when the zone cooling demand is +0.1°F, or less, for at least 60 seconds, and no compressors are running.

In CV cooling operation with a zone sensor and when free cooling is available ("economizer suitable"), the SAT is controlled by the economizer control algorithm (see section Economizer Operation later in this document). The zone sensor, in a way similar to the thermostat control in cooling operation with economizer, resets the SAT setpoint using an algorithm illustrated below:

Note: Zone temperature may drop below setpoint only when destaging compressors during a transition from cooling to satisfied state.

4.7 Vav Operation

The paragraphs below identifies control modes of VAV operation and provides an overview of control methods in all modes. The modes include Occupied and Unoccupied Heating and Cooling and differ depending on the method used to control zone temperature (thermostat, or a space sensor). The heating vs. cooling modes are entered under control of the thermostat, or, in case of space sensor, by control algorithm detecting zone cooling, or heating demand. The "occupied" vs. "unoccupied" modes are controlled by a signal generated by the thermostat, or by an external "Occupied/unoccupied" signal source (such as a time clock). If a thermostat is connected in addition to the space sensor, it takes priority over the space sensor.

4.7.1 VAV OPERATION WITH A THERMOSTAT

The thermostat is placed in a selected, representative zone of a VAV system and is used to reset SAT and cycle the VAV unit in cooling and to control heating. It is expected that the thermostat provide Y1, Y2 outputs to control cooling and W1 output to control heating. The thermostat is expected to be programmed to switch between occupied and unoccupied heating and cooling setpoints, and provides an output to control occupied/unoccupied mode (a contact closure that supplies in the occupied mode 24VAC to the MOD UNT "Occ." Input).

As the thermostat has a capability to turn off the unit in occupied cooling mode, it is important to place it in a zone that is representative of the remaining zones, or is a zone with the highest occupied cooling demand. The zone is controlled by its own zone thermostat to a temperature setpoint set independently of the

setpoints of the "system control" thermostat; the setting of the occupied cooling setpoint on the "system control" thermostat should at least roughly correlate to the zone temperature setpoint. For example, the occupied cooling setpoint may be set at, or below the lowest zone temperature setpoint selectable on the zone thermostat. The setpoint setting should prevent a possibility of cooling turned off while other zone(s) in the system still have a cooling demand.

The use of a zone thermostat is indicated to the controller by setting ON a programmable parameter "VAV Operation with Thermostat".

4.7.2 VAV OPERATION WITH A ZONE SENSOR

The Space Sensor is placed in a selected, representative zone of a VAV system. It is used to reset SAT in cooling and to control occupied heating based on comparison of zone temperature to a programmed "VAV Setpoint for SAT Reset". However, since the zone is controlled by its own zone thermostat to a temperature setpoint set independently of the VAV Setpoint for SAT reset, the setting of the VAV Setpoint for SAT reset should at least roughly correlate to the zone temperature setpoint. For example, the VAV Setpoint for SAT reset may be set at, or below the lowest zone temperature setpoint selectable on the zone thermostat, in order to prevent a possibility of insufficient cooling while other zone(s) in the system still have a high cooling demand. In unoccupied modes, the Space Sensor controls the unit based on unoccupied heating and cooling setpoints programmed in the unit controller.

The use of a Space Sensor is enabled by setting a programmable parameter "VAV Operation with Thermostat". When the Space Sensor is enabled, the control self-configures to a VAV operation with a Space Sensor if the sensor is available, to stand-alone operation if the sensor is not available.

4.7.3 STANDALONE VAV OPERATION

In standalone operation the control unit receives an occupied/unoccupied command from an external source (such as a time clock). In occupied cooling mode, it controls to the Low SAT setpoint. In unoccupied mode, the unit shuts down. In unoccupied mode, an external (network) command may be provided to start a Morning Warmup cycle. The MWU cycle (if enabled) will also start upon a transition from Unoccupied to Occupied mode.

Supply fan overrun

In heating modes of VAV operation, when the control transitions to a satisfied state, the fan output will continue until the SAT drops below a specified limit. The limit is 100° F and there is a 5°F differential to prevent fan cycling, i.e. the fan will go off when the SAT drops below 95°F.

In cooling modes of VAV operation, when the control transitions to a satisfied state, and only when the programmable option "Fan Overrun" is set to ON, the fan output will continue for 60 seconds.

Occupied heating with a thermostat

When the programmable parameter "VAV Operation with Thermostat" is set to ON and the unit enters the “Occupied” mode heating is started by the thermostat turning ON its W1 output. In the Occupied mode the thermostat will control to its occupied heating setpoint.

The thermostat's occupied heating setpoint should be set well below the zone thermostat's cooling setpoint, to represent a heating setpoint typical for all system zones.

Full heating (all heating stages ON) occurs when W1=ON, and no heating (all heating stages OFF) occurs when W1=OFF (note that

in this case, the control will use all available heating stages, regardless of setting of the programmable parameter "Heat Stages").

The supply fan operates at 100% during heating and is controlled by the thermostat's G output. Depending on the setting of the thermostat's fan switch (AUTO, or ON), the fan will cycle On/Off with the W1 output, or will remain On. On startup, the fan speed is ramped up, or the inlet vanes ramped open (a "soft start").

During occupied heating, the economizer damper remains at minimum position and all VAV boxes are fully open - box heat relays are energized from Heat 1 output of the controller. If Hydronic heat option is used, the Heat 1 output of the controller is also actuated during heating, the SAT is controlled to the 2nd stage hydronic heat setpoint.

Unoccupied heating with a thermostat
This operation is identical to the Occupied heating, except the unit mode must be set to "unoccupied" by an "unoccupied" output of the thermostat (an open contact). Also, the thermostat is programmed to control to its unoccupied heating setpoint and the economizer damper remains fully closed in the unoccupied mode.

Occupied cooling with a thermostat
In this mode, the control uses a thermostat for cooling and fan operation. The thermostat's occupied cooling setpoint should be set below the zone thermostat's lowest adjustable cooling setpoint, to prevent a possibility of cooling turned off while other zone(s) in the system still have a cooling demand.

Unoccupied cooling with a thermostat
This operation is identical to the Occupied cooling, except when operating in the unoccupied mode the thermostat is programmed to control to its unoccupied cooling setpoint and the economizer damper min. position is set to 0%, however the damper may modulate open if outdoor air can be used for free cooling (economizer operation).

Occupied heating with a Space Sensor
the Space Sensor is placed in a selected, representative zone of the VAV system, in addition to the zone thermostat, or sensor used to control the zone's VAV box.

The heating control algorithm is enabled whenever the zone temperature drops 2°F or more below a programmed "VAV Setpoint for SAT reset", and disabled whenever the zone temperature is 1.5°F, or less below a programmed "VAV Setpoint for SAT reset". The "VAV Setpoint for SAT Reset" would typically be set at, or below the lowest zone temperature setpoint selectable on the zone thermostat.

The supply fan is controlled to 100% during occupied heating and cycles OFF when the heating control algorithm is satisfied. On startup, the fan speed is ramped up, or the inlet vanes ramped open (a "soft start").

When a call for heating (W1 or W2=ON) occurs, the economizer damper remains at its programmed minimum position and all VAV boxes go fully open - box heat relays are energized from Heat 1 output of the controller.

If Hydronic heat option is used, the Heat 1 output of the controller is also actuated during heating and the SAT is controlled to the 2nd stage hydronic heat setpoint.

Unoccupied heating with a Space Sensor
When this mode is enabled and the unit enters the unoccupied mode, the unit will control heating by comparing the zone temperature to a programmed "Unoccupied Heating Setpoint". The Space Sensor should be placed in a selected, representative zone of

the VAV system, in addition to the zone thermostat, or sensor used to control the zone's VAV box.

Full heating (all heating stages ON) occurs when the Space Sensor algorithm requests heating, no heating (all heating stages OFF) when the Space Sensor algorithm is satisfied (note that in this case, the control will use all available heating stages, regardless of setting of the programmable parameter "Heat Stages").

The supply fan is controlled to 100% during unoccupied heating and cycles OFF when the Space Sensor control algorithm is satisfied. On startup, the fan speed is ramped up, or the inlet vanes ramped open (a "soft start").

During unoccupied heating, the economizer damper is fully closed and all VAV boxes go fully open - box heat relays are energized from Heat 1 output of the controller.

Occupied cooling with a Space Sensor
This mode is entered when the programmable parameter "VAV Operation with Thermostat" is set to OFF and the unit enters the "occupied" mode. The Space Sensor requests cooling (to a programmed High, or Low SAT setpoint) whenever the zone temperature increases by a specified amount above a programmed "VAV Setpoint for SAT reset".

The Space Sensor should be placed in a selected, representative zone of the VAV system, in addition to the zone thermostat, or sensor used to control the zone's VAV box.

The "VAV Setpoint for SAT Reset" would typically be set at, or below the lowest zone temperature setpoint selectable on the zone thermostat, in order to prevent a possibility of insufficient cooling while other zone(s) in the system still have a high cooling demand.

The supply fan, economizer, VAV boxes operate within their normal control algorithms.

Unoccupied cooling with a Space Sensor
In this mode, the Space Sensor requests cooling based on comparing the zone temperature to a programmed "Unoccupied Cooling Setpoint".

When the Space Sensor control algorithm requests cooling, the unit runs cooling controlled to a programmed High SAT setpoint ("VAV High Temperature Setpoint for Cooling"), or to a programmed Low SAT Setpoint ("VAV High Temperature Setpoint for Cooling"), as determined by comparison of zone temperature to a programmed "VAV Setpoint for SAT reset". The "VAV Setpoint for SAT Reset" would typically be set well below the "Unoccupied Cooling Setpoint", causing the unoccupied cooling to typically use a Low SAT Setpoint.

There are two different SAT control algorithms, one used when free cooling is available (economizer operation) and the other one for mechanical cooling only. These two SAT control algorithms are described in the “Occupied Cooling in Standalone Operation” section below.

Unoccupied heating in standalone operation
When the unit mode enters the "unoccupied" state by a signal from an external source (such as a time clock) (an open contact) the unit remains shut down, unoccupied heating is never used.

Occupied cooling in standalone operation
The unit controls cooling to a programmed Low SAT setpoint ("VAV Low Temperature Setpoint for Cooling") during the occupied mode. There are two different SAT control algorithms, one used when free cooling is

available (economizer operation) and the other one for mechanical cooling only.

First, when free cooling is available ("economizer suitable"), the SAT control algorithm is as described in the Economizer Operation section later in this document, except the programmed Economizer First Stage Setpoint and Economizer Second Stage Setpoint are replaced by the programmed VAV High Temperature Setpoint for Cooling and VAV Low Temperature Setpoint for Cooling.

When free cooling is not available, the SAT control is performed by the following control algorithm:

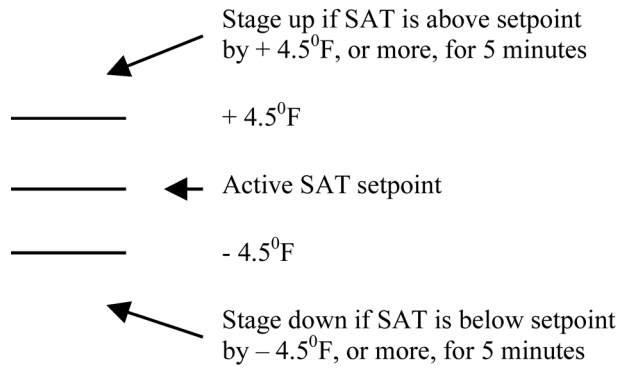

Stage up if SAT is above setpoint
by + 4.5⁰F, or more, for 5 minutes
+ 4.5⁰F
Active SAT setpoint
- 4.5⁰F
Stage down if SAT is below setpoint
by – 4.5⁰F, or more, for 5 minutes

Fig 4.3: SAT Control Band

Minimum compressor off times (ASCD) of 5 minutes and minimum on times of 3 minutes are maintained and the cycling rate of the compressors will not exceed maximum 6 cycles/hour. The SAT is controlled in a ±4.5°F band around the active SAT setpoint. The control algorithm includes a provision for a Predicted SAT Drop as defined in the Controlling Excessive SAT section later in this document: A compressor is allowed to turn on only if the current SAT minus the Predicted SAT Drop is more than 51°F.

4.8 Supply Duct Static Pressure Control algorithm

The Supply Duct Static pressure is controlled to a specified setpoint (see paragraph Duct Static Setpoint, section Option Operation earlier in this document). An appropriate closed loop control algorithm (a standard MOD UNT PI "primitive") is used to control the supply duct static pressure by modulating Inlet Guide Vanes, or supply fan VFD.

4.9 Morning Warm Up / VAV Occupied Heating control algorithm

How is Morning Warm Up started:
Non-networked systems: The Morning Warm Up option has to be enabled. The MWU option is factory-enabled for all VAV units with heat If enabled, MWU (Morning Warm Up) is initiated upon all transitions from Unoccupied to Occupied mode. The Occupancy signal is used to identify, for the Morning Warm Up, a 1 hour period before actual occupancy begins. It is important to note that the unit is still operating in an Unoccupied mode for the first hour after the Occupancy input is turned On. If the MWU feature is enabled, all scheduled Occupancy periods must be set to start 1 hour ahead of the actual Occupied time. This is because the controller (MOD-UNT) does not have a stand-alone real-time calendar/clock and does not perform scheduling. The externally generated Occupancy signal is used to identify the MWU start time for the controller. The actual occupancy period is then started 1 hour later as measured by an internal controller timer. If the MWU option is disabled, the occupancies should be scheduled at their regular time.

Networked systems: The Morning Warm Up is initiated the same way as in non-networked systems, i.e. the occupancy period also must be scheduled to start 1 hour ahead of the actual occupancy time. In addition, a network head-end device may start the Morning Warm

Up even earlier, before the Occupancy input is turned On. The network head-end device software may be programmed to start Morning Warm Up either at a fixed time before the first occupied time of the day, or at a time determined by an Unoccupied Recovery algorithm. The network command initiating Morning Warm Up may be issued only in an unoccupied mode. The network command must stay active for the duration of the Morning Warmup cycle (or until it is replaced by the Occupied signal).

Note that the Unoccupied Override function that is implemented in Constant Volume systems can not be implemented in VAV systems, because it would conflict with the implementation of Morning Warm Up (the MWU is initiated upon all transitions from Unoccupied to Occupied mode).

Morning Warm Up / VAV Occupied heating function:
Morning Warm Up controls the RAT to a preprogrammed Morning Warm Up RAT Setpoint. An appropriate closed loop control algorithm is used to control heat stages to accomplish this. The algorithm uses a deadband (i.e. control RAT between the MWU RAT Setpoint and two degrees below the setpoint). Full heating (all stages) is ON when RAT drops 2°F below the setpoint, heating is OFF when RAT is at, or above the setpoint. (Note that in this case, the control will use all available heating stages, regardless of setting of the programmable parameter "Heat Stages"). Before energizing heat for Morning Warm Up the control will start the Fan and operate it for 5 minutes. The Economizer will stay closed and the Fan will continue to run during the Morning Warm Up. The Morning Warm Up will terminate when the Occupied period begins (1 hour after the Occupied input was turned On), but will not continue beyond the specified Max Morning Warm Up Time.

If the RAT setpoint is achieved before the MWU period expires, Unoccupied cooling is permitted. If further heating is needed during the Occupied period, it is controlled by a VAV Occupied Heating algorithm (if enabled and if a Space Sensor is used), or by a space thermostat.

The same algorithm is also used for VAV Occupied Heating (see also paragraph "VAV Occupied heating" in "Option Operation" section earlier in this document). In this case, the VAV Occupied Heating control algorithm is activated under the control of the Space Sensor (whenever the zone temperature sensed by the Space Sensor drops 2°F or more below a programmed "VAV Setpoint for SAT reset"). Once activated, the Occupied Heating control algorithm controls RAT between the MWU RAT Setpoint and two degrees below the setpoint and cycles the fan the same way as the MWU algorithm. The VAV Occupied Heating algorithm is disabled whenever the zone temperature is 1.5°F, or less below a programmed "VAV Setpoint for SAT reset". The specified Max Morning Warm Up Time is not used to limit the duration of VAV Occupied Heating.

During heating for Morning Warm Up, or for VAV Occupied heating function, the VAV boxes controls will receive an override signal to open the VAV box damper. This is accomplished by wiring the VAV heat relay for the VAV boxes to, and energizing it from Heat 1 output of the MOD UNT controller. Note that as the first stage of heat cycles on / off, the VAV box heat relay will cycle with it.

4.9.1 UNOCCUPIED VAV HEATING / COOLING CONTROL ALGORITHM WITH A SPACE SENSOR

In the unoccupied mode, the Space Sensor will compare the temperature in a selected VAV zone to the programmed Unoccupied Heating and Cooling setpoints and request

heating, or cooling using the following control algorithm:

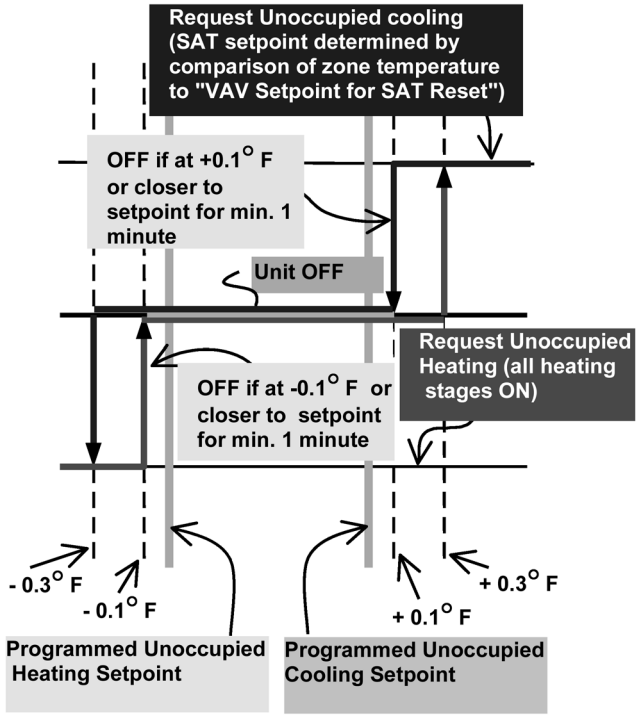

Request Unoccupied cooling (SAT setpoint determined by comparison of zone temperature to "VAV Setpoint for SAT Reset")
OFF if at +0.1° F or closer to setpoint for min. 1 minute
Unit OFF
Request Unoccupied Heating (all heating stages ON)
OFF if at -0.1° F or closer to setpoint for min. 1 minute
- 0.3° F
- 0.1° F
+ 0.1° F
+ 0.3° F
Programmed Unoccupied Heating Setpoint
Programmed Unoccupied Cooling Setpoint

Fig 4.4: Unoccupied VAV Control for SAT Reset

4.9.2 OCCUPIED VAV HEATING / COOLING CONTROL ALGORITHM WITH A SPACE SENSOR

In the occupied mode, the Space Sensor will compare the temperature in a selected VAV zone to the programmed "VAV Setpoint for SAT Reset" and request heating, or cooling using the following control algorithm:

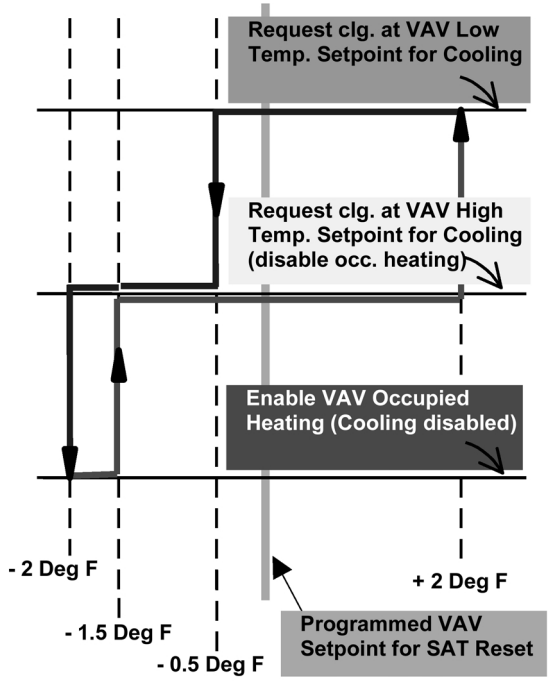

Request clg. at VAV Low Temp. Setpoint for Cooling
Request clg. at VAV High Temp. Setpoint for Cooling (disable occ. heating)
Enable VAV Occupied Heating (Cooling disabled)
- 2 Deg F
+ 2 Deg F
- 1.5 Deg F
- 0.5 Deg F
Programmed VAV Setpoint for SAT Reset

Fig 4.5: Occupied VAV Control for SAT Reset

The transition from cooling to occupied heating occurs at 2°F below the "VAV Setpoint for SAT reset" and the reverse transition at 1.5°F below the "VAV Setpoint for SAT reset". There is no "satisfied", or "idle" state of the unit between cooling and occupied heating.

The above algorithm only requests occupied cooling and selects a SAT occupied cooling setpoint, or requests occupied heating at a programmed "Morning Warm Up RAT Setpoint". Once requested by this Space Sensor algorithm, the cooling is controlled by the SAT control algorithm described in paragraph "SAT Control Algorithm in VAV Cooling" earlier in this section. Once requested by this Space Sensor algorithm, the occupied heating is controlled by the RAT control algorithm described in paragraph "Morning Warm Up / VAV Occupied Heating Control Algorithm" earlier in this section.

4.10 Controlling Excessive SAT (Supply Air Temperature)

This is required in cooling operation in order to prevent a danger of "slugging" and damage to the DX compressors. Rooftop units do not use accumulators on compressor intake, and liquid refrigerant could enter the intake of a compressor in case of a low heat transfer on the evaporator coil. In heating operation, the Excessive SAT control is not used.

4.10.1 SAT CONTROL CONFIGURATION

SAT control for cooling is configurable to enable or disable (on/off). The default setting for cooling is ON. The user is not normally expected to turn this mode OFF, but the possibility of turning it OFF is provided mainly for troubleshooting purposes.

Compressor SAT Trip Points

SAT compressor trip points are user configurable. Each compressor has its own SAT trip point and is turned off if the SAT drops below it. The Cooling SAT trip points for compressors #2 through #4 are programmable between 40°F and 65°F in one degree increments. The trip point for compressor #1 is programmable only between 40°F and 50°F. This is because its trip point always needs to be below the modulating band of Economizer Loading function in case this function is used.

The programmability of the cooling trip points is limited such that a trip point setting of a compressor can not be lower than a trip point setting of a previous (lower numbered) compressor. The trip points for compressors #1 through #4 must be set in an ascending order. For example, a 50°F cooling trip point setting for compressor #1 becomes the lowest allowed trip point setting for compressor #2, etc. The PalmPilot User Configuration tool will ensure a proper correlation of trip point settings, and also ensure that all these are set lower than the Economizer First Stage Setpoint and Economizer Second Stage Setpoint. The default cooling trip point is 50°F for all compressors.

4.10.2 SAT CONTROL FOR COOLING

This control has priority over any other zone temperature or SAT control and is used at all times, during CV as well as VAV operation.

The Excessive SAT Control state is entered any time the SAT drops below the trip point of a compressor (as the trip points are programmed in an ascending sequence, the compressor that trips will always be the highest-numbered one).

While in this state, the control will continue monitoring the SAT and turning off compressors any time the SAT drops below the respective trip point. There is a 2 minute time delay between compressor trips in cases when the SAT drops below trip points of multiple compressors. This assures that multiple compressors will not be turned off simultaneously.

4.10.3 ECONOMIZER LOADING OPERATION DURING AN EXCESSIVE SAT FOR COOLING:

CV ECONOMIZER OPERATION

Economizer dampers allow mixing of outdoor and return air. The dampers are coupled and controlled with a single actuator such that when the Outdoor Air damper is fully closed, the Return Air damper is fully open (and vice versa). The position of the Economizer dampers is controlled based on:

1. Energy considerations (“free cooling”)

2. Ventilation considerations (minimum Outdoor Air damper position and Demand Ventilation)

3.Space static pressure considerations (minimum Outdoor Air damper position).

Economizer dampers are also controlled in certain situations to perform “economizer loading” – which minimizes SAT temperature swings resulting from turning cooling, or heating stages on / off. This function is separate from normal economizer operation, and is separately described at the end of this section

When is the Economizer operation used?

If the rooftop unit is equipped with an economizer (and that option is selected), and free cooling is available (“economizer suitable”), then the Economizer Operation as specified in this section will be used in the following operation modes:

CV cooling with thermostat, or zone temperature sensor control (note that in the zone sensor mode, the compressor staging algorithm defined in this Economizer section will replace the zone sensor-based control described in Sensor Operation in CV Operation section, earlier in this document)

Minimum Ventilation Position setting

The minimum position setting represents the minimum opening of the outdoor air damper (% open). This setting will be maintained any time the unit is in Occupied mode. The minimum position setting will be determined either by a dipswitch, or by an “Economizer Min Position” programmable parameter set by a PalmPilot User Configuration tool. If the DIP switch is enabled (# 8 switch set to ON), the control will use the minimum position setting determined by the DIP switch. If the DIP switch is disabled, the control will use the minimum position setting determined by the programmable parameter “Economizer Min Position”.

The minimum position setting will be ignored during the Unoccupied mode. During the Unoccupied mode, the minimum position is 0% (the Economizer may not remain closed during the Unoccupied mode, in case the temperature control to an unoccupied setpoint can use Outside Air for free cooling).

Minimum Position during Heating and Occupied Mode

During heating while in Occupied mode, the economizer will be at its programmed minimum position.

Minimum Position during Cooling and Occupied Mode

During cooling while in Occupied Mode, the economizer may be at its programmed minimum or may be modulated between its minimum position and 100% open position by the economizer control.

SAT setpoints used during cooling with Economizer Operation:

As long as the Economizer Operation is enabled and “free cooling” is available, the economizer will be controlled (with, or without any compressors running) to maintain the following SAT setpoints:

In CV cooling mode:

- With a call for first stage cooling, a programmed Economizer First Stage Setpoint. This setpoint is programmable in the range of 40^0 F to 65^0 F, default setting is 55^0 F
- With a call for second stage cooling, a programmed Economizer Second Stage Setpoint. This setpoint is programmable in the range of 40^0 F to 65^0 F, default setting is 50^0 F

Criteria for Economizer Suitable decision

Sensor availability: There are three different methods of deciding whether the economizer is suitable - **differential enthalpy** (highest preference from energy viewpoint), **outside enthalpy** (middle preference) and **outside temperature method** (lowest preference). The choice of a method with highest preference is automatic ("self-configuration) based on availability of appropriate sensors. If a sensor fails/ goes unreliable, a fault is indicated and, again, the next highest preference method will be automatically selected ("fault tolerance").

There are two ON/OFF programmable parameters related to the choice of an economizer method: "OAH Sensor Enable" and "RAH Sensor Enable". These parameters are set to reflect the installed sensors that can be used by the "self-configuration" feature and control sensor failure alarms. The OAH sensor, if available, allows use of Outside Enthalpy method for deciding on free cooling availability. The RAH sensor, if available in addition to the OAH sensor, allows use of Differential Enthalpy method for deciding on free cooling availability. See paragraphs OAH Sensor Enable and RAH Sensor Enable in Option Operation section earlier in this document.

If the selected method is using an enthalpy, the enthalpy is calculated in the controller from sensed temperature and humidity of the respective air stream.

Differential enthalpy method: will be self-configured and used only when sensors for Outdoor Air temperature, Outdoor Air humidity, Return Air temperature and Return Air humidity are all installed and reliable

Outside enthalpy method: will be self-configured and used only when differential enthalpy method is not available, and sensors for Outdoor Air temperature and Outdoor Air humidity are installed and reliable

Outside temperature method: will be self-configured and used only when differential enthalpy or outside enthalpy methods are not available, and sensor for Outside Air temperature is installed and reliable

Outside temperature method:
Economizer is suitable when OAT is less than SAT setpoint + 10^0 F.

Use a 2^0 F differential on both sides of this limit. As the SAT setpoint value, use only one of the programmed 1^{st} or 2^{nd} stage economizer setpoints (depending on what cooling stage is called), not any "transient" setpoints that may be temporarily used during process of staging. Note that this rule does not reflect any consideration of geographical location and weather conditions, but rather reflects the average expected SAT temperature drop obtained from DX cooling stages, i.e. the highest outdoor air temperature that the DX cooling can still reliably reduce to the SAT setpoint

Outside Enthalpy method: Economizer is suitable when OA Enthalpy is less than Outside Enthalpy number AND OAT is less than SAT setpoint + 10^0 F:

Use a 2^0 F and 1 BTU/LB differentials respectively on both sides of these limits. The Enthalpy number is a programmed parameter (range 22-40 BTU/LB, default 30 BTU/LB. The Enthalpy Number can be viewed as the maximum outdoor air enthalpy with which the outside air can still be considered suitable for DX cooling, or,

in comparison to the Differential Enthalpy Method described below, as a “best guess” on actual return air enthalpy (which in this method is not being sensed). The temperature limit reflects the average expected SAT temperature drop obtained from DX cooling stages.

Differential Enthalpy Method:
Economizer is suitable when OA Enthalpy is less than the RA Enthalpy AND OAT is less than SAT setpoint plus 10^0 F (+/- 2^0 and 1 BTU/LB):

Use a 2^0 F and 1 BTU/LB differentials respectively on both sides of these limits. This is similar to the Outside Enthalpy method, except instead of a programmed Enthalpy Number, an actually sensed return air enthalpy is used.

SAT control with Economizer

The economizer control uses a standard PI algorithm. If the economizer is “suitable” (free cooling is available) and cooling is required (the unit is not in satisfied state), the algorithm will be active and modulate economizer position in order to control SAT to the active SAT setpoint. If the economizer is not suitable, the algorithm is deactivated and the economizer is placed at its programmed minimum position.

The economizer control algorithm will typically be cycled ON/OFF several times an hour (will be activated and deactivated) under control of a zone thermostat, or a zone sensor. A zone control algorithm will activate the economizer algorithm when cooling is required, and will switch between Economizer 1^{st} and 2^{nd} stage SAT setpoints, and will deactivate the economizer algorithm when the zone is satisfied.

The economizer control algorithm includes special provisions (sometimes referred to as a “bumpless transfer” feature) that allow it to resume control of SAT as fast as possible when it is re-activated during the ON / OFF cycling (when a zone thermostat, or zone sensor requests cooling and the control exits its satisfied state). In its OFF-state, the control algorithm continues monitoring the SAT and performs calculations necessary to set its output, which controls the economizer dampers, to have the same value on starting the ON-cycle as it had when it went into the OFF-cycle (in spite of some increase in the SAT during the OFF-cycle).

The “bumpless transfer” feature of the economizer control algorithm essentially acts similar to a “memory” that holds the algorithm output during the OFF-cycles. This “memory” is reset only on unit shutdown. The effect of this “memory” can be observed on the action of the economizer dampers. After unit startup (during the first ON-cycle of the economizer), there is no “memorized” output value and the dampers move relatively slowly into a control position required to maintain SAT setpoint. On subsequent ON-cycles, the dampers move into a control position much faster as dictated by the output value stored in control algorithm “memory”. The “memorized” output value is also retained during transfers between occupied and unoccupied mode.

The PI algorithm is direct acting. This economizer control algorithm is always active during economizer operation (as long as economizer is “suitable”) and will control SAT to an active (1^{st} or 2^{nd} stage) Economizer setpoint. This means that this control loop not only modulates the Outside Air damper open to add free cooling and decrease mixed air temperature to maintain SAT at setpoint, but, when DX cooling is running, also may modulate the Outside Air damper closed to increase mixed air temperature (use more return air) and thus add load on the DX coil to maintain SAT at setpoint (“economizer loading”). This repre-

sents a trade-off between energy and compressor cycling.

Note that per the defined criteria for “Economizer Suitable” decision, a situation may arise when the economizer is still suitable (i.e. OAT is less than SAT setpoint + 10^0 F) and yet OAT > RAT. In that (a fairly unusual) situation, the economizer control PI algorithm should ideally be changed into reverse acting mode in order to correctly accomplish the “economizer loading” function. This change into reverse acting mode will not be implemented in order to simplify the application code *(the control of compressor staging, utilizing High saturation state of the economizer controller as described in the following paragraph, would also have to be changed).* The benefit of implementing this would be minimal in any case as in that condition the OAT and RAT will be very nearly the same. If these two temperatures were not very close, i.e. if OAT would further increase above the RAT, it would cause the economizer to become unsuitable and this control algorithm would no longer be applicable.

Note however, that the switching of the Economizer control PI algorithm between Direct and Reverse acting mode is still required in the Economizer Loading mode (where the compressor staging is not involved and the High Saturation state of the controller is not utilized) – see Economizer Loading Option description later in this section.

Control of compressors with Economizer

Compressors are turned On / OFF individually, regardless of grouping them into “stages”. The stage groups are used only for control of compressors with external signals, such as from a thermostat.

Turning ON of compressor #1:

Never operate compression if the Economizer can maintain the SAT setpoint with free cooling. If no compressors are on, and the economizer controller is saturated High (i.e. the economizer is 100% open and can no longer maintain the SAT setpoint by just free cooling),

- Temporarily override SAT setpoint to increase it by 5^0 F
- When the SAT is within 0.5^0 F of this temporary setpoint, turn on compressor #1
- Resume SAT control at active setpoint

  This is done in order to read and store the SAT temperature differential (drop) due to turning on compressor #1, while assuring that turning it on will not drop the SAT below compressor #1 trip point (where the Excessive SAT control would turn it off again). The same staging sequence is used for the remaining compressors (see below). Note that the standard 5 minute delay before monitoring SAT after a compressor is turned on, or off, applies here also.

Turning on compressors #2 through #4:

If the economizer controller is saturated High (i.e. the economizer is 100% open while one or more compressors are running and the control can no longer maintain the active SAT setpoint requested by the zone control),

- Temporarily override SAT setpoint to increase it by 5^0 F
- When the SAT is within 0.5^0 F of this temporary setpoint, turn on the next compressor
- Resume SAT control at active setpoint
  Note that the pre-staging SAT increase must be done “pro actively”, by a temporary override of the active SAT setpoint, rather than by allowing the SAT to”drift” up by 5^0 F out of control. The time it would take for the SAT to “drift” up could be fairly

long, mostly dependent on the outdoor air temperature change and in the meantime, the zone temperature may go out of control as the additional needed cooling is not being delivered.

Note that the standard 5 minute delay before monitoring SAT after a compressor is turned on, or off, and the checking against a stored, predicted SAT temperature drop, applies here also.

Turning compressors off:

A highest numbered running compressor is turned off when the economizer controller is saturated Low.

This method of turning compressor off is considered better than using the Excessive SAT Control – turning a compressor OFF only if SAT reaches its specified trip point. If that method was used and the Excessive SAT Control was not selected, there would be no means for turning compressors off.

Note that the compressors also will be turned off in CV systems with zone thermostat, or zone sensor temperature control, when the zone temperature control is satisfied. For the case of zone sensor, the compressor destaging is described in section “CV Operation”, paragraph “Control Algorithm for Cooling with the Sensor Option, with Economizer”. For the case of zone thermostat, the compressor destaging is described in section “CV Operation”, paragraph “Thermostat Operation for Cooling with Y1 and Y2 inputs”, subparagraph “”Economizer Mode”.

Compressor control when exiting Cooling Lockout on OAT:

A situation may arise when in Economizer Mode and one or more compressors are required in addition to full available free cooling in order to maintain the SAT setpoint, but Cooling Lockout on OAT prevents the compressors use. This situation may arise when the SAT setpoint is set very close to, or even below the temperature set for Cooling Lockout on OAT – a relatively unusual case. If the OAT then increases above the lockout setting while the call for several compressors exists, the compressors in this case (and only in this case) will turn on simultaneously. This is considered acceptable as this situation is not expected to occur frequently.

Economizer Loading Option

This is a *programmable* option. The user has the ability to turn this function off. It is automatically disabled if the unit does not use an economizer. The on/off programming choice is common to both cooling and heating. The default setting is ON. This programmable “Economizer Loading” function is used only outside the normal Economizer operation. During the Economizer operation, the “loading” function is always used and is an integral part of the Economizer control algorithm.

Economizer loading option in cooling:

In cooling, this function causes changes in mixed air temperature (as modulated by the economizer dampers) in order to change SAT and keep it at SAT setpoint when only compressor #1 is running. This makes a trade-off between energy and compressor cycling and minimizes cycling of compressor #1.

The loading is done by the same type of control algorithm (PI) as used in the normal Economizer operation. The algorithm will be activated to do this function in following conditions:

- Economizer is “not suitable” (i.e. we are not in a normal Economizer mode)
- The programmable option “Economizer Loading to Control SAT” is ON

- Only compressor #1 is running

The PI control algorithm in this case has a capability to automatically change from direct to reverse acting in response to difference between OAT and RAT. When OAT is less than RAT, the algorithm is direct acting, for OAT ≥ RAT, the algorithm changes to reverse acting. This way, the "loading" of the DX coil is correctly done with return, or outdoor air, as appropriate, and there is no need to activate this "loading" function only at higher outdoor air temperatures (e.g. OAT > 60^0 F).

The algorithm controls SAT to its specified setpoint (when applicable, e.g. in VAV operation), or, in control modes where no SAT setpoint is specified (such as in Excessive SAT control state in cooling), to a fixed temperature deadband of 50^0 F to 55^0 F.

Note that, as opposed to the PI algorithm used in economizer control, the PI algorithm used here for economizer loading function does not need to utilize the High saturation state for any additional control functions. Therefore no complications arise when switching between direct and reverse acting modes.

Economizer loading option in heating:

In heating, this function uses additional outside air (as modulated by the economizer dampers) in order to decrease SAT when only the first stage of heating is running and keep the SAT below the programmed "Economizer Loading Setpoint in Heating". This prevents heating stage from cycling on its internal temperature limit safety switch (which is typically set about 10^0 F above the Economizer Loading Setpoint). A need for economizer loading arises in Communicating Zoning System applications ("VVT" systems) using supply air bypass when heating load in the zones is low and a large amount of hot supply air is bypassed back into return and mixed air temperature is very high. Economizer loading may also be needed when supply air flow across the heat exchanger is lower than expected (e.g. wrong setting of fan speed, plugged air filters). A secondary benefit of economizer loading is an improvement in comfort as the supply air temperature is more stable and cycling of the unit is minimized.
The economizer loading option in heating is not implemented in VAV applications as these do not use supply air bypass and (in case of using a zone thermostat) run all heating stages during heating (economizer loading applies to only the 1^{st} heating stage).

The economizer loading minimizes cycling of heating stage #1 and makes a trade-off between energy and the benefits described above.

The Economizer Loading in heating option requires a SAT sensor that can sense SAT in heating mode (a sensor placed downstream of the heating stages). Such a sensor is provided only as a field-installed accessory, on units equipped with heating stages. The SAT sensor that is factory-installed can be used for cooling mode only. If a field-installed sensor is added, it will replace the factory-installed one and will then be usable for both heating and cooling modes.

The loading is done by the similar control algorithm as used in the normal economizer operation. The algorithm is activated to do this function in following conditions:

- Heating mode
- The programmable option "Economizer Loading to Control SAT" is ON
- only heating stage #1 is running

The PI control algorithm in this case has a capability to automatically change from direct to reverse acting in response to difference between OAT and RAT. When OAT is less than RAT the algorithm is direct acting, when OAT ≥ RAT the algorithm is reverse acting. This way, the “loading” of the heating stage is correctly done with return, or outdoor air, as appropriate, and there is no need to activate this “loading” function only in some specific range of outdoor air temperatures (e.g. OAT > programmed first heating stage trip point minus 50^0 F).

Note that in this case, the provision for direct vs. reverse acting switching is not essential feature of the control algorithm and the algorithm could be implemented as direct acting only in order to simplify implementation and save code space. The situation when economizer loading in heating is required while OAT ≥ RAT is unlikely and if it should occur, the difference between OAT and RAT is negligible in comparison to the SAT control setpoint.

The Economizer Loading function in heating controls SAT to a fixed temperature deadband of programmed “Economizer Loading Setpoint in Heating” and 5^0F below this setpoint (the setpoint is programmable between 100^0 F - 195^0 F, default is 160^0 F).

In units that use hydronic heat, the Economizer Loading function may be enabled in order to be used for cooling (the on/off programming choice for this function is common to both cooling and heating). In this case, it is important to ensure that the programmed value of the “Economizer Loading Setpoint in Heating” is set higher than the value of “Hydronic Heat First Stage Setpoint”. That, in normal conditions, assures that the Economizer Loading function in heating is effectively disabled and the economizer is closed to its minimum position during heating.

VAV

When is the Economizer operation used? If the rooftop unit is equipped with an economizer and free cooling is available then the Economizer Operation as specified in this sectionis used in the following operation modes:

VAV cooling (except the programmed Economizer First Stage Setpoint and Economizer Second Stage Setpoint are replaced by the programmed VAV High Temperature Setpoint for Cooling and VAV Low Temperature Setpoint for Cooling)

4.11 Demand Ventilation

Demand Ventilation Operation control mode is self-configuring for the use of an Indoor Air Quality (IAQ) sensor - it will automatically detect that an IAQ sensor is connected and use it any time the IAQ sensor input indicates an IAQ level of 200 ppm, or higher.

Note that due to the self-configuration operation, an error due to IAQ sensor failure can be indicated only in case the IAQ sensor fails during normal controller operation. If the IAQ sensor fails, or is removed / disconnected during a power-off condition (e.g. during servicing of the unit while the control is not powered), the control will, on power up, self-configure without the IAQ sensor and no error indication is provided.

When the IAQ sensor is detected as available, the control will use the Demand Ventilation Setpoint to control the IAQ levels in the building by modulating the Economizer more open.

The Demand Ventilation will operate in units equipped with an Economizer (Economizer option is turned ON) any time the control is in Occupied mode. The Demand Ventilation Operation is applicable in heating, or cooling

mode, and will modulate the Economizer damper more open, if necessary, from its programmed minimum position (in heating, or in cooling when economizer is not "suitable"), or from its modulated position determined as defined in the Economizer Operation section (in cooling, when economizer is "suitable").

An appropriate control algorithm is used to accomplish this control. Preferably, this algorithm is a "step-and-wait" type, with the step size calculated as a function of offset between the Demand Ventilation Setpoint and the current IAQ level, and with a fixed "wait", or sampling time. This algorithm is activated whenever the IAQ level exceeds the setpoint and will override the economizer position more open, as needed, up to a pre programmed Maximum Economizer Position for Demand Ventilation. The algorithm is deactivated, and the previous, normal mode of economizer position control resumed when the IAQ level becomes 50 ppm lower than the setpoint.

The programmed "Maximum Economizer Position for Demand Ventilation" is used to minimize the possibility that the Demand Ventilation may open the Economizer damper too much, such that at fairly high OA temperatures, even combined cooling output of all compressors would not provide sufficient cooling (as a rule of thumb, all compressors combined achieve approx. 20°F SAT decrease). Similarly, at fairly low OA temperatures, the combined output of all heating stages may not be able to provide sufficient heating. This Economizer max. position limit is simpler to implement than a closed loop SAT low-limit control that would operate with a programmed high-limit for cooling and a programmed low limit for heating. Note that an added measure of protection against excessive SAT during Demand Ventilation Operation is provided by Supply Air Alarm Setpoint for Cooling and Supply Air Alarm Setpoint for Heating, and the control function associated with these setpoints (see the respective paragraphs in the Option Operation section earlier in this document).

4.12 Exhaust Operation

Building static pressure is controlled through one of three methods. One method incorporates a fixed speed fan that is controlled from the position of the Economizer dampers. A second method uses proportional control that modulates the exhaust damper and operates the fan based on the position of the dampers. A third method also uses a two position control that looks at building static pressure and supply fan status.

Two-Position Control (Non Modulating Power Exhaust)

This mode is a fixed speed, ON/OFF Power exhaust fan, with a barometric relief damper, controlled from position of the Economizer damper. The Power Exhaust and the Economizer options must be ON.

The Exhaust Fan (EF) is controlled with a relay output of the MOD-UNT controller and "slaved" to the Economizer damper position. The EF relay is energized whenever the Supply Fan is running and the Economizer (Outdoor Air Damper) is commanded open more than the programmed Economizer Damper Position for Exhaust Fan to turn ON. The EF relay is de-energized when supply fan is off or when the Economizer (OAD) opening is less than the programmed Economizer Damper Position for Exhaust Fan to turn OFF, or 10% open, whichever is greater. Default Setpoint settings for the EF to turn ON at Economizer 60% open, turn OFF at Economizer 20% open. The EF has a minimum run time of 10 seconds and a minimum off time of 60 seconds.

Proportional Control (Fan with Modulating Exhaust Air Damper (EAD) controlled from building static pressure)
In this mode the Power Exhaust, Modulating Exhaust, Economizer and Building Pressure Sensor Enable options must be ON and the Supply Fan must be running. The EAD actuator is modulated to maintain building static pressure to a programmed Building Pressure Setpoint. An appropriate closed loop control algorithm is used to accomplish this control. Recommended tuning parameters for the control algorithm: modulate from full closed to full open over a 2-minute period. The proportional band should be from 0.015 in w.g. (3.7 Pa) below the Building Pressure Setpoint to 0.015-in. w.g. (3.7 Pa) above the set point. The control algorithm is disabled and exhaust air damper commanded closed whenever the supply fan is off.

Building pressure is sensed with - 0.250 to + 0.250 in. w.g. (-31 to + 31 Pa) 0 - 5V output pressure differential transducer. The transducer senses the building pressure as referenced to an appropriate reference point outside the building. Transducer output signal is filtered (e.g. time averaged over 15 second period) to compensate for wind gusts.

The Exhaust Fan (EF) is controlled with a relay output of the MOD-UNT controller and "slaved" to the Exhaust Air Damper position. The EF relay is energized whenever the Supply fan is running and the EAD is open more than the programmed Exhaust Damper Position for Exhaust Fan to turn ON. The EF relay is de-energized when Supply fan is off or when the EAD opening is less than the programmed Exhaust Damper Position for Exhaust Fan to turn OFF, or 10% open, whichever is greater. The minimum run time is 10 seconds and minimum off time is 60 seconds. (Non-adjustable). Default Setpoint settings are for the EF to turn ON at Exhaust Air Damper 80% open and turn OFF at Exhaust Air Damper 20% open. The Building Pressure Setpoint default is 0.100 " w.g.

Two-Position Control (Power Exhaust with Barometric relief, controlled from building static pressure)
In this mode the Power Exhaust, Economizer and Building Pressure Sensor Enable options must be ON. The Exhaust Fan (EF) is controlled with a relay output of the MOD-UNT controller. The EF relay is energized whenever Supply fan is running and building static pressure is above a programmed Building Pressure Setpoint + 0.015 in. w.g. (3.7 Pa). The EF relay is de-energized when supply fan is off, or when building static pressure is less than a programmed Building Pressure Setpoint - 0.015 in. w.g. (3.7 Pa). The minimum run time is 10 seconds and minimum off time 60 seconds (Non-adjustable). With this type of control, the Power Exhaust fan cycle, as its operation directly influences the building static pressure that controls it. The cycling rate is limited by these minimum ON and OFF time settings. The Building Pressure Setpoint default is 0.100" w.g.

4.13 Scheduling Operation

Scheduling is not implemented internal to the MOD UNT since the MOD UNT does not have a calendar/clock capability. In non-networked CV application with a programmable thermostat, the rooftop either is always in Occupied mode (a jumper on the thermostat interface board from 24VAC to OCC input), or the thermostat has an occupancy output that controls OCC/UNOCC modes. Occupied/Unoccupied scheduling can then be done in the thermostat. Unoccupied Recovery can be done only if the thermostat performs it.

Non-Networked Applications
In VAV non-networked applications, the rooftop either is always in Occupied mode (a jumper on thermostat interface board from

24VAC to OCC input), or an external, programmable time clock can optionally be used to control OCC input to accomplish OCC/UNOCC mode selection. Morning Warmup (when enabled) is initiated upon a transition from Unoccupied to Occupied mode. When Morning Warm Up is enabled, all Occupied times must be scheduled 1 hour ahead of actual occupancy (to allow 1 hour for Morning Warm Up - see "VAV Operation" section, paragraph "Morning Warm Up / VAV Occupied Heating Control Algorithm").

Networked Applications
In networked applications, the network head end device performs the scheduling function and sends an Occupied / Unoccupied command to the MOD UNT controller. Morning Warmup function is handled by head-end network software (network would command the unit to start cooling or heating towards the occupied setpoint for a CV system, or could start Morning Warm Up for a VAV system earlier than upon a transition from Unoccupied to Occupied mode as described in paragraph above).

4.14 Compressor Status Monitoring

Compressor status is monitored using a 24 VAC input from "compressor safety chain". If a compressor control output is turned ON, the corresponding compressor status input should also be ON. If not, it means that one of the switches connected in series as a "compressor safety chain" opened. The "compressor safety chain" includes a High Refrigerant Pressure limit switch, and may include compressor motor overload switch, if the switch is external. Low Refrigerant pressure limit switch is connected separately. The Low Refrigerant Pressure Switch is Normally Open, pressure closed. When compressor is off and refrigerant pressure equalized, the switch under normal conditions is expected to be closed. However, in cold ambient operation, it may stay open and close only after the compressor starts up.

If 24vac is not detected for a compressor while monitoring the compressors, for more than 250 ms, that compressor’s output is turned off (note that the MOD UNT controller executes the application code once every 1.5 second, i.e. the compressor status input is scanned and the appropriate action taken at that sampling rate). Exception to this is on compressor startup, where a 30 sec delay is used in monitoring the "safety chain" switches.

The control then declares a "Compressor Locked Out on Safety Chain Trip" alarm. The alarm is written to the Error History Buffer and triggers storing a snapshot of Points Screen data along with a date and time stamp. In networked applications, the alarm flag is readable by the network. The control will wait 10 minutes and turn the compressor back on as long as there is still a need for it. At this point the alarm is automatically reset (regardless of whether the compressor is needed, or not).

Store the fact that something tripped the compressor in a counter. Try this three times. After the third try if it still trips out, lock that compressor out. At this point, the "Compressor Locked Out on Safety Chain Trip" alarm is set and will remain set. The compressor lock out (and the alarm) must be reset (after the compressor problem that caused it is corrected) by resetting the MOD UNT controller (power cycle, or reset command issued by the PalmPilot Configuration Tool).

If on one of the re-tries the compressor continues to operate, wait an hour and reset the lockout tries counter.

Note that the compressor lockout works as an override of the output of the staging algorithm for cooling control. For example, the cooling

control may ask for compressor #2 that is locked out, and as this request does not generate additional cooling, will ask for the next compressor, #3, to satisfy the cooling demand. If, after 10 minutes, the requested compressor #2 does start up, the cooling output now may be exceeding demand, and the control will turn off compressor #3, etc.

4.15 Low Ambient Operation

When a Millennium unit has the Low Ambient Temperature Kit installed, the Low Ambient Resistor should be installed or the LAR parameter is programmed “ON” using the PalmPilot. The the control can then operate compressors # 1 and # 2 down to 0°F OAT (the Low Ambient Kit affects only operation of these two compressors). The LAR operation has priority over the OAT for cooling lockout ("Cooling Lockout on OAT" setting). Turning ON the programmable "Low Ambient Kit Installed" option described in the paragraph below has the same result as installing the LAR, and would be used in applications where the LAR input is used for an alternative function (FZR contact).

Chapter 5: Troubleshooting a Millennium Synthesis Control

5.1 Status LED Chart

The Status LED mounted on the MOD UNT controller PC board will flash specified flash patterns to indicate rooftop unit status and/or various failures and allow simple diagnostics.

Flash times

The control will flash 300ms on and 300ms off for error codes. The control will flash the last active error code for local diagnostics. Only the active alarms will be flashed. The control will separate the flash codes with a 1.5 second off delay between flash codes. Under normal operation, the control will flash the LED at a rate of, 500ms on and 500ms off. This is the “Heart Beat”.

Flash Codes	Description
On Steady	This is a Control Failure
1 Flash	Cooling or Heating Locked out on OAT
2 Flashes	Compressor command fault
3 Flashes *	Cooling SAT failure
4 Flashes *	Heating SAT failure
5 Flashes *	SAT, RAT, OAT, IAQ, Space temperature, or a Relative Humidity Sensor failure
6 Flashes *	Fan Failure
7 Flashes *	Duct Static or Building Pressure Sensor failure
8 Flashes	Compressor turned off due to freeze Stat
9 Flashes *	Compressor locked out on safety chain trip
OFF	No Power or Control Failure

Fig 5.1: MOD-UNT Flash Code Chart

If there are multiple active errors, only the highest priority error will be flashed. The error indicated by the highest number of flashes has the highest priority.

The “Compressor command fault” error will be flashed in situations when there is a discrepancy between a command for a compressor and the actual status of the compressor, i.e. when the compressor command is temporarily overridden by a minimum run time for cooling, or by ASCD for cooling, or when a compressor is turned off due to a safety chain trip, or by a freeze ‘stat (however, the error “Compressor turned off due to freeze ‘stat” will be indicated as it has a higher priority).

The system errors for which the error codes are marked with the asterisk (*) will also be entered into error history buffer, along with a snapshot of Points Screen data, as specified later in this document. In networked application, the error flag will be readable by the network.

Status LED Chart

The Status LED mounted on the MOD UNT controller PC board will flash specified flash patterns to indicate rooftop unit status and/or various failures and allow simple diagnostics.

The control will flash 300ms on and 300ms off for error codes. The control will flash the last active error code for local diagnostics. Only the active alarms will be flashed. The control will separate the flash codes with a 1.5 second off delay between flash codes.

If there are multiple active errors, only the highest priority error will be flashed. The error indicated by the highest number of flashes has the highest priority.

The "Compressor command fault" error will be flashed in situations when there is a discrepancy between a command for a compressor and the actual status of the compressor, i.e. when the compressor command is temporarily overridden by a minimum run time for

cooling, by ASCD for cooling, when a compressor is turned off due to a safety chain trip, or by a freeze 'stat (however, the error "Compressor turned off due to freeze 'stat" will be indicated as it has a higher priority).

5.2 Failure Modes and Default Operation

Error Histories

Error data storage: The control will store the latest ten errors and data ("error data snapshots") associated with the errors in EEPROM, for later display when using the PalmPilot User Configuration Tool. The control will store, for each error (or combination of multiple errors), a Date and Time stamp indicating when the error occurred, and the Points Screen data. It will also store status information ("active" vs. "inactive") for all error types to provide for situations when an error data snapshot is triggered by multiple errors occurring at the same time. The content and format of the Error History Screen and Error History Snap Shot Screen used to display this data is shown in the respective paragraphs later in this document. The control will store the last ten errors in a FIFO manner. As the control collects errors, it will overwrite the oldest error after the history buffer becomes full.

Date and time stamp: The Date and Time Stamp stored with error data is valid only in networked applications. In non-networked applications, the recorded date value will be 00/00/00. PalmPilot user tool will always display the date/time stamp. If the date is shown as invalid (00/00/00), the displayed time shall be interpreted as "elapsed time since last MOD UNT reset". This time display still provides to a service person some guidance in judging elapsed time between faults in one maintenance session. This time display without a valid date should be used for only short time periods, as the 24-hour MOD UNT clock rolls over and starts again at zero time every 24 hours.

Errors that are entered into error history buffer and trigger storing of snap shot data:

Compressor locked out on safety chain trip
Supply fan failure
Heating SAT failure
Cooling SAT failure
SAT,RAT,OAT,IAQ, ST, or RH failure
Duct static or Bldg. Pressure sensor failure
Dirty Filter alarm
High duct static alarm
Hot Water Coil Freeze alarm
External alarm input
Bad Air Proving Switch

Handling of persistent errors, repeated errors and multiple errors: If an error (or multiple errors) remain active and persist for a long time, but no new errors occur, and no errors get corrected, error data snapshots will be stored repeatedly at a time interval of 20 minutes.

If the same error should periodically reoccur, it will be re-recorded again only at time intervals of minimum 20 minutes.

This prevents rapidly filling the error snapshot buffer with multiple snapshots related to the same error.

Two identical errors can be recorded in two consecutive locations in the buffer only if they are recorded at a time interval of 20, or more minutes.

This technique allows a periodically reoccurring error to be re-recorded only after 20 minutes, or only as "every other error", in case some other errors occur and get recorded in between. This technique provides a reasonable "compromise" between a too-frequent

recording of a reoccurring error (losing other faults history) and ignoring a reoccurring error (e.g. an intermittent sensor where recording the error just once would not provide truly useful diagnostic data).

In situations where multiple errors exist, storing of an error data snapshot can be triggered by multiple errors occurring at the same time, or by an additional error being added to multiple, already existing errors. Storing of an error data snapshot can also be triggered by one of multiple errors being corrected.

3Status LED: Several (but not all) of the errors listed above are also indicated (when active) by the Status LED. See the paragraph Status LED Chart earlier in this document.

Internal MOD UNT controller hardware and firmware failures These errors are handled internally to the MOD UNT.

5.3 Sensor Failures and Default Operation

A failure of SAT RAT, OAT, IAQ, Space Temperature, or an outside or return air Relative Humidity sensor will generate a common error. A failure of the Duct Static or Building Pressure sensor will generate another common error. The errors will be indicated by a Status LED (see Status LED Chart earlier in this chapter). The errors will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

The error indication of a sensor failure will continue until the problem is corrected and will automatically terminate when the sensor is again detected as reliable. If the unit is shut down as a result of a sensor failure, the alarm must be reset (after the sensor problem has been corrected) by resetting the MOD UNT controller (power cycle, or reset command issued by the PalmPilot Configuration Tool).

SAT Sensor
CV operation: If the SAT sensor fails, the Economizer, excessive SAT control and predicted SAT drop checking will be disabled. The Control will then continue a "limp along" operation under zone thermostat, or zone sensor control. For VAV operation the unit will be shut down.

RAT Sensor
If the RAT sensor fails, Morning Warm Up mode and VAV Occupied Heating are disabled. For Economizer Loading function, the control will default to estimated RAT of 75°F (for this function only).

OAT Sensor
Units without Economizer: If there is no Economizer, the control will lockout Cooling on an OAT sensor failure. This is because the controller can not determine when cooling needs to be locked out at low OAT to prevent damage to compressors. Heating operation will continue normally.

Units with Economizer: All Economizer Operation will be disabled. This is because OAT sensor is the most essential sensor in determining availability of free cooling. Even if the unit is equipped with Outside RH sensor and controller could calculate Outdoor Enthalpy, the OAT sensor is still essential in that calculation. The Economizer will only modulate to the Minimum Position when the Fan is operating and the control is Occupied.

Outside Air Relative Humidity Sensor
If the OAH sensor fails, the control will only use the OAT sensor to decide if Free Cooling is available. The control will self-configure to Outside Temperature Method (see also Econ-

omizer Operation section earlier in this document).

Return Air Relative Humidity Sensor
The control will self-configure to Outside Enthalpy Operation.

Space Temperature Sensor
CV operation with a zone sensor: When this sensor fails the control will see if it has a RAT sensor. If it has a RAT sensor, the control will use it as a backup and continue temperature control to the active space temperature setpoint. If there is no RAT Sensor, the control will shut down all outputs.

If the detected sensor failure is a short circuit, the error can be declared only if the short persists for several minutes, in order to distinguish a sensor failure from a short caused by somebody pushing on Unoccupied Override button.

VAV operation: If the space temperature sensor fails, the control will continue normal function, only SAT reset from space temperature will be disabled.

Building Pressure Sensor
If this sensor fails, the Power Exhaust control will default to operate as a two position Power Exhaust. The Power Exhaust Fan will be controlled as a fixed speed, ON/OFF Power exhaust fan, controlled from position of the Economizer damper. If the unit is equipped with a Modulating Exhaust Air Damper, this damper will be closed.

Duct Static Pressure Sensor
If this sensor fails, all outputs are turned off and the unit is shut down.

IAQ Sensor
If the IAQ sensor fails, Demand Ventilation mode is de-activated.

5.4 System Errors

Heating SAT Failure
In Heating mode and all stages of heating energized, the SAT must drive above the Supply Air Alarm Setpoint for Heating within ten minutes or this SAT failure error will be activated.

The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

Cooling SAT Failure
In Cooling mode and all stages of compression are energized, the SAT must drive below the Supply Air Alarm Setpoint for Cooling within ten minutes or this SAT failure error will be activated.

The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

Supply Fan Failure
The conditions under which this failure is declared, and the follow-up actions of the control when this error occurs are described in a paragraph on Air Proving Switch Operation earlier in this document.

The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

Compressor Safety Chain Trip
The conditions under which this failure is declared, and the follow-up actions of the control when this error occurs are described in a

paragraph on Compressor Status Monitoring earlier in this document. The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

Dirty Filter Alarm
The conditions under which this failure is declared, and the follow-up actions of the control when this error occurs are described in a paragraph on Dirty Filter Switch option earlier in this document. The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

High Duct Static alarm
The conditions under which this failure is declared, and the follow-up actions of the control when this error occurs are described in a paragraph on Duct Static High Limit Setpoint option earlier in this document. The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

Hot Water Coil Freeze Alarm
The conditions under which this failure is declared, and the follow-up actions of the control when this error occurs are described in a paragraph on FZR (Hot Water Freeze Protection) option earlier in this document. The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

External Alarm Input
The conditions under which this failure is declared, and the follow-up actions of the control when this error occurs are described in a paragraph on Alarm Input option earlier in this document. The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

Bad Air Proving Switch Error
The conditions under which this failure is declared, and the follow-up actions of the control when this error occurs are described in a paragraph on Air Proving Switch Operation earlier in this document. The error will be written to the Error History Buffer and will trigger storing a snapshot of Points Screen data along with a date and time stamp. In networked application, the error flag will be readable by the network.

Fault Tolerance
Cooling: When Y1 or Y2 are detected as active, the software will turn on the corresponding output, if it has been off for at least five minutes (Anti-Short Cycle Delay). The control will provide a fault tolerance for the thermostat's Y1, Y2 and G outputs. If only Y2 is detected, the software will interpret it as both Y1 and Y2 on simultaneously. When the control detects both Y1 and Y2 inputs simultaneously, the software will turn on stage-one and then stage-two after five minutes. Always energize stage-one first, because of the split-face coil designs. If an error has occurred locking out one of the compressors of stage-one, then the remaining stage-one compressors will continue to operate with Y1. If all stage one compressors are locked out, Y2 will eventually turn on stage two compressors. The compressor lockout works as an override of the thermostat output, forcing the thermostat to ask for additional cooling. If G has not been detected before Y1 output is energized, the control will energize the Fan output and

wait for the Air Proving Switch to close before it energizes stage one.

Heating: When W1 or W2 inputs are detected, the software will turn on the corresponding output, if it has been off for two minutes (Anti-Short Cycle Delay). The control will provide a fault tolerance for the thermostat's W1, W2 and G outputs. If only W2 is detected, the software will interpret it as both W1 and W2 on simultaneously. If both W1 and W2 are detected simultaneously, the software will turn on heat stage 1 output and then heat stage 2 output after one minute (Interstage Delay for Heating). If G has not been detected before W1 output is energized the software will energize the fan output and wait for the Air Proving Switch to close before it energizes heat stage 1.

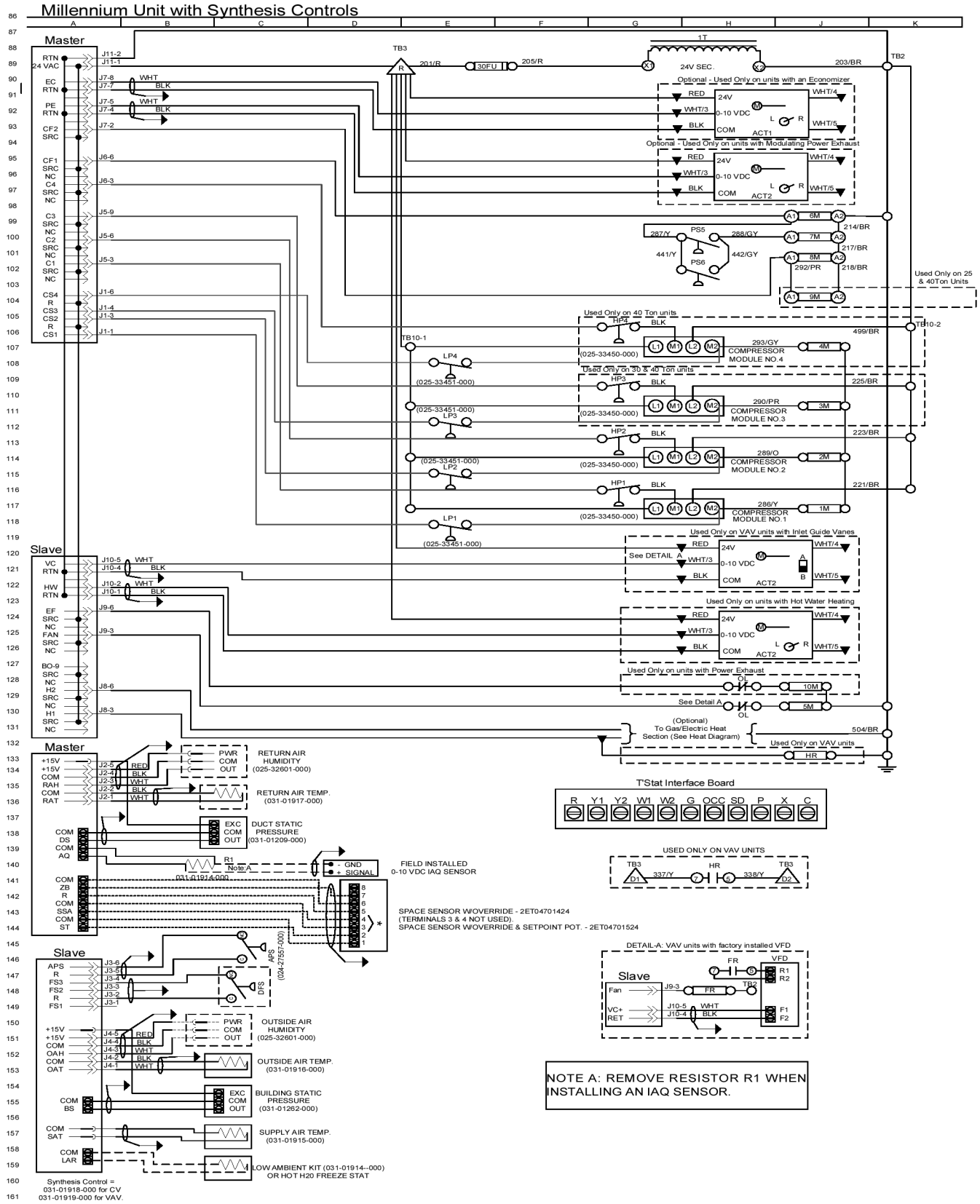
Appendix A: Acronym Chart

Acronym Chart

This chart contains the acronyms used for the hardware input and output devices and sensors described throughout this training manual.

APS	Air Proving Switch (Fan Status)
AQ/AQ+	Air Quality (CO^2 Sensor)
BS/BS+	Building Static
C1-C4	Cooling Outputs 1,2,3,4
CF1&CF2	Condenser Fan Outputs
CS1-CS4	Compressor Status 1,2,3,4
CV	Constant Volume
DF	Dirty Filter
DS/DS+	Duct Static
EAD	Exhaust Air Damper
EC-/EC+	Economizer Output
EF	Exhaust Fan
FS1-FS2	Freeze Stat 1,2
Fan	Fan Output
FZR	Freeze Resistor Board
G	Thermostat Input for the Fan
H1-H3	Heating Outputs 1,2,3
HW-/HW+	Hot Water Valve Output
LAR	Low Ambient Resistor
OAD	Outside Air Damper
OAT	Outside Air Temperature
OCC	Occupied Input
P	Purge Input
PE-/PE+	Power Exhaust Output
RAT	Return Air Temperature
SAT	Supply Air Temperature
SD	Shut Down Input
SO/SO+	Outside Relative Humidity
SR/SR+	Return Relative Humidity
SSA	Space Setpoint Adjust
ST	Space Temperature
VAV	Variable Air Volume
VC-/VC+	VFD or Inlet Guide Vane Output
W1	Thermostat Input for the first stage of Heating
W2	Thermostat Input for the second stage of Heating
X	Alarm Output
Y1	Thermostat Input for the first stage of Cooling
Y2	Thermostat Input for the second stage of Cooling

Appendix B: Hardware Connection Diagram


Millennium Unit with Synthesis Controls
Master
Slave
Master
Slave
TB3
1T
24V SEC.
TB2
Optional - Used Only on units with an Economizer
Optional - Used Only on units with Modulating Power Exhaust
ACT1
ACT2
PS5
PS6
Used Only on 25 & 40Ton Units
Used Only on 40 Ton units
Used Only on 30 & 40 Ton units
COMPRESSOR MODULE NO.4
COMPRESSOR MODULE NO.3
COMPRESSOR MODULE NO.2
COMPRESSOR MODULE NO.1
Used Only on VAV units with Inlet Guide Vanes
Used Only on units with Hot Water Heating
Used Only on units with Power Exhaust
See Detail A
(Optional)
To Gas/Electric Heat Section (See Heat Diagram)
Used Only on VAV units
T'Stat Interface Board
R Y1 Y2 W1 W2 G OCC SD P X C
USED ONLY ON VAV UNITS
RETURN AIR HUMIDITY (025-32601-000)
RETURN AIR TEMP. (031-01917-000)
DUCT STATIC PRESSURE (031-01209-000)
FIELD INSTALLED 0-10 VDC IAQ SENSOR
SPACE SENSOR W/OVERRIDE - 2ET04701424
(TERMINALS 3 & 4 NOT USED).
SPACE SENSOR W/OVERRIDE & SETPOINT POT. - 2ET04701524
DETAIL-A: VAV units with factory installed VFD
OUTSIDE AIR HUMIDITY (025-32601-000)
OUTSIDE AIR TEMP. (031-01916-000)
BUILDING STATIC PRESSURE (031-01262-000)
SUPPLY AIR TEMP. (031-01915-000)
LOW AMBIENT KIT (031-01914--000) OR HOT H20 FREEZE STAT
Synthesis Control = 031-01918-000 for CV 031-01919-000 for VAV.
NOTE A: REMOVE RESISTOR R1 WHEN INSTALLING AN IAQ SENSOR.

Appendix C: Options Chart including Defaults

Option Chart Including Factory Programmed Default Values

This chart lists all user-defined parameters that can be displayed and set using the PalmPilot configuration tool. This allows the application code, common to all controllers, to be tailored for the specific rooftop unit model.

The defaults shown in this chart will be the “basic” default settings for all application parameters, downloaded along with the application code to the MOD UNT controllers in JCI factory. Some of these default values will then be modified on YORK factory floor to fit the specific rooftop unit model on which the controller will be used.

The chart’s leftmost column identifies which parameters (and related option operation) are implemented only in the CV, or only in the VAV controller respectively, and which are implemented in both. The common type parameters are denoted with (--).

Type	Option	Range	Default
--	**Metric Operation**	ON – OFF	OFF
--	**Compressors**	1 – 4	2
CV	**Heat Stages**	0 – 2 0 = disabled	2
--	**Hydronic Heat**	ON – OFF	OFF
--	**Hydronic Heat First Stage SAT Setpoint**	80° - 180°	130°
--	**Hydronic Heat Second Stage SAT Setpoint**	80° - 180°	145°
CV	**Economizer Loading Setpoint in Heating**	100° - 195°	150°
--	**SAT Control for Cooling**	ON – OFF	ON
--	**Compressor One Cooling Limit**	40° - 50°	45°
--	**Compressor Two Cooling Limit**	40° - 65°	50°
--	**Compressor Three Cooling Limit**	40° - 65°	50°
--	**Compressor Four Cooling Limit**	40° - 65°	50°
--	**Power Exhaust**	ON – OFF	ON
--	**Modulating Exhaust**	ON – OFF	OFF
--	**Exhaust Damper Position for Exhaust Fan to turn ON (Modulating Only)**	0 – 100%	80%
--	**Exhaust Damper Position for Exhaust Fan to turn OFF (Modulating Only)**	0 – 100%	20%
--	**Economizer (ODA) Damper Position for Exhaust Fan to turn ON (Non-Modulating Only)**	0 – 100%	60%
--	**Economizer (ODA) Damper Position for Exhaust Fan to turn OFF (Non-Modulating Only)**	0 – 100%	20%
--	**Building Pressure Sensor Enable**	ON – OFF	OFF
--	**Building Pressure Setpoint**	-0.200” – +0.200” w.g.	0.100” w.g.
--	**Economizer**	ON – OFF	ON
--	**Economizer Min Position**	0 – 100%	20%
CV	**Economizer First Stage Setpoint**	40° - 65°	55°
CV	**Economizer Second Stage Setpoint**	40° - 65°	50°

Option Chart Continued…

--	**OAH Sensor Enable**	ON – OFF	OFF
--	**Outside Enthalpy Number**	22 – 40 BTU/LB	30
--	**RAH Sensor Enable**	ON – OFF	OFF
--	**Economizer Loading to Control SAT**	ON – OFF	ON
VAV	**VAV Operation with thermostat**	ON – OFF	ON
VAV	**Duct Static Setpoint**	0.000" – 5.000" w.g.	1.500" w.g.
VAV	**Duct Static High Limit Setpoint**	0.000" – 5.000" w.g.	4.500" w.g.
VAV	**Morning Warm Up**	ON – OFF	OFF
VAV	**Max Morning Warm Up Time**	1 – 4 hours	2 hours
VAV	**Morning Warm Up RAT Setpoint**	50° - 85°	70°
VAV	**VAV High Temperature Setpoint for Cooling**	40° - 70°	60°
VAV	**VAV Low Temperature Setpoint for Cooling**	40° - 70°	55°
VAV	**VAV Setpoint for SAT Reset**	40° - 85°	72°
VAV	**VAV Occupied Heating**	ON – OFF	OFF
CV	**Comfort Ventilation Mode**	ON – OFF	OFF
CV	**Comfort Ventilation High Supply Air Setpoint**	60° - 85°	80°
CV	**Comfort Ventilation Low Supply Air Setpoint**	60° - 85°	70°
CV	**Comfort Ventilation Max Economizer Position**	0 – 100%	75%
--	**Condenser Fan Operation Option**	1 – 3	2
--	**Dirty Filter Switch**	ON – OFF	ON
--	**Heating Lockout on OAT**	0° - 100°	75°
--	**Cooling Lockout on OAT**	0° - 100°	45°
--	**Unoccupied Heating Setpoint**	45° - 99°	60°
--	**Unoccupied Cooling Setpoint**	45° - 99°	85°
CV	**Occupied Heating Setpoint**	45° - 99°	68°
CV	**Occupied Cooling Setpoint**	45° - 99°	72°
--	**Freeze Thermostats**	0 – 2 0 = disabled	0
--	**FZR (Hot Water Freeze Protection)**	ON – OFF	OFF
--	**Supply Air Alarm Setpoint for Cooling**	0/50° - 80° 0 = disabled	0° disabled
--	**Supply Air Alarm Setpoint for Heating**	0/70° - 120° 0 = disabled	0° disabled
CV	**Unoccupied Override Time Limit**	0 – 240 mins 0 = disabled	60 minutes
--	**Fan Overrun**	ON – OFF	ON
CV	**Fan ON Mode with the Sensor option**	ON – OFF	ON
--	**Space Sensor Enable**	ON – OFF	OFF
--	**RAT Sensor Enable**	ON – OFF	OFF
--	**Demand Ventilation Setpoint**	700ppm – 1500ppm	1000 PPM
--	**Max Economizer Position for Demand Ventilation**	0 – 100%	50%
--	**IAQ Sensor Range**	0 - 10,000 PPM	5,000 PPM
--	**Alarm Input**	ON – OFF	OFF
--	**Low Ambient Kit Installed**	ON – OFF	OFF
--	**Cooling Mode Enable**	ON – OFF	ON
--	**Heating Mode Enable**	ON – OFF	ON
--	**Space Temperature Setpoint Offset**	0° – 5° F	3° F
--	**Two Compressors per Circuit**	ON – OFF	OFF

Appendix D: Fault Code, Delay & Timing

YORK Synthesys® Unitary - Controller

SYNTHESYS DELAYS AND TIMERS	
ASCD for cooling	Minimum OFF time C1=4:40 C2=4:50 C3=5:00 C4=5:10 (minutes : seconds)
ASCD for SAT trip (cooling)	10 Minutes OFF time
ASCD for SAT trip (heating)	5 Minutes OFF time
ASCD for heating	2 Minutes minimum OFF time
Energy Saver Delay	1 Minute between turning on Compressors, Cooling/Heating Stages
Minimum Run Time for Cooling	3 Minutes for all Compressors
Minimum Run Time for Heating	2 minutes for all Stages
Supply Fan ASCD	30 Second minimum OFF time
Delay to allow SAT to stabilize	5 minute delay used any time a compressor, or heating stage is turned on, or off, before using the SAT reading for any control decisions

FLASH CODES	DESCRIPTION
On Steady	This is a Control Failure
1 Flashes	Cooling or Heating Locked out on OAT
2 Flashes	Compressor waiting ASCD
3 Flashes *	Cooling SAT failure
4 Flashes *	Heating SAT failure
5 Flashes *	SAT, RAT, OAT, IAQ, ST, OAH, RAH failure
6 Flashes * &	Fan Failure
7 Flashes * &	Duct Static or Building Pressure Sensor failure
8 Flashes	Compressor turned off due to Freeze Stat
9 Flash	Compressor locked out on safety chain trip
OFF	No Power or Control Failure

(*) System errors will be entered into Error History Buffer along with a snapshot of Points Screen data

(&) These faults require a controller RESET to clear.

Appendix E: DIP Switch Chart

The Configuration DIP switch is used in standalone applications to provide basic control settings, accessible to a service person who does not use the PalmPilot User Configuration tool. As long as the DIP switch is enabled (#8 switch set to ON), the DIP switch settings take priority over the equivalent settings programmed by the PalmPilot User Configuration Tool (or over the default values of these settings set in the factory). If the DIP switch is disabled, the control uses the programmed settings. The PalmPilot software will be able to read the DIP switch enable/disable status and display a note indicating this status to a PalmPilot user who is accessing and/or changing the Economizer minimum position, or Building Pressure Setpoint. Note however, that when the DIP switch is enabled and its settings take priority, the PalmPilot still displays its own programmed settings, **not the DIP switch settings now in use**.

The one-time commands to Override ASCD timers and/or to start Run Test can be issued by either the PalmPilot User Tool, or by the DIP switch, if enabled.

Dip Switch Positions								**Operation**
1	2	3	4	5	6	7	8	
Economizer / Minimum Ventilation Position								**Economizer / Minimum Ventilation Position**
Off	**Off**	**Off**	NA	NA	NA	NA	NA	No Economizer Attached
On	**Off**	**Off**	NA	NA	NA	NA	NA	Economizer W/ 0% Minimum Outdoor Air
Off	**On**	**Off**	NA	NA	NA	NA	NA	Economizer W/ 10% Minimum Outdoor Air
On	**On**	**Off**	NA	NA	NA	NA	NA	Economizer W/ 15% Minimum Outdoor Air
Off	**Off**	**On**	NA	NA	NA	NA	NA	Economizer W/ 20% Minimum Outdoor Air
On	**Off**	**On**	NA	NA	NA	NA	NA	Economizer W/ 25% Minimum Outdoor Air
Off	**On**	**On**	NA	NA	NA	NA	NA	Economizer W/ 30% Minimum Outdoor Air
On	**On**	**On**	NA	NA	NA	NA	NA	Economizer W/ 35% Minimum Outdoor Air
Building Pressure Setpoint								**Building Pressure Setpoint**
NA	NA	NA	**Off**	**Off**	NA	NA	NA	.025 in. w.g.
NA	NA	NA	**On**	**Off**	NA	NA	NA	.050 in. w.g.
NA	NA	NA	**Off**	**On**	NA	NA	NA	.100 in. w.g.
NA	NA	NA	**On**	**On**	NA	NA	NA	.150 in. w.g.
ASCD Override								**ASCD Override**
NA	NA	NA	NA	NA	**Off**	NA	NA	Normal Operation
NA	NA	NA	NA	NA	**On**	NA	NA	Override all ASCDs for one cycle with 30 seconds
Run Test (Commissioning Operation)								**Run Test (Commissioning Operation)**
NA	NA	NA	NA	NA	NA	**Off**	NA	Normal Operation
NA	NA	NA	NA	NA	NA	**On**	NA	Run Test for one Cycle
								DIP Switch Enable / Disable
NA	NA	NA	NA	NA	NA	NA	**Off**	disabled
NA	NA	NA	NA	NA	NA	NA	**On**	enabled

The DIP switch is shipped from the factory with the #8 switch in “Enabled” position, and with #6 and #7 (command) switches set to OFF, and with switches #1 through #5 set for a default 20% minimum Economizer position and 0.100” w.g. building pressure setpoint.

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YORK®

Heating and Air Conditioning

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